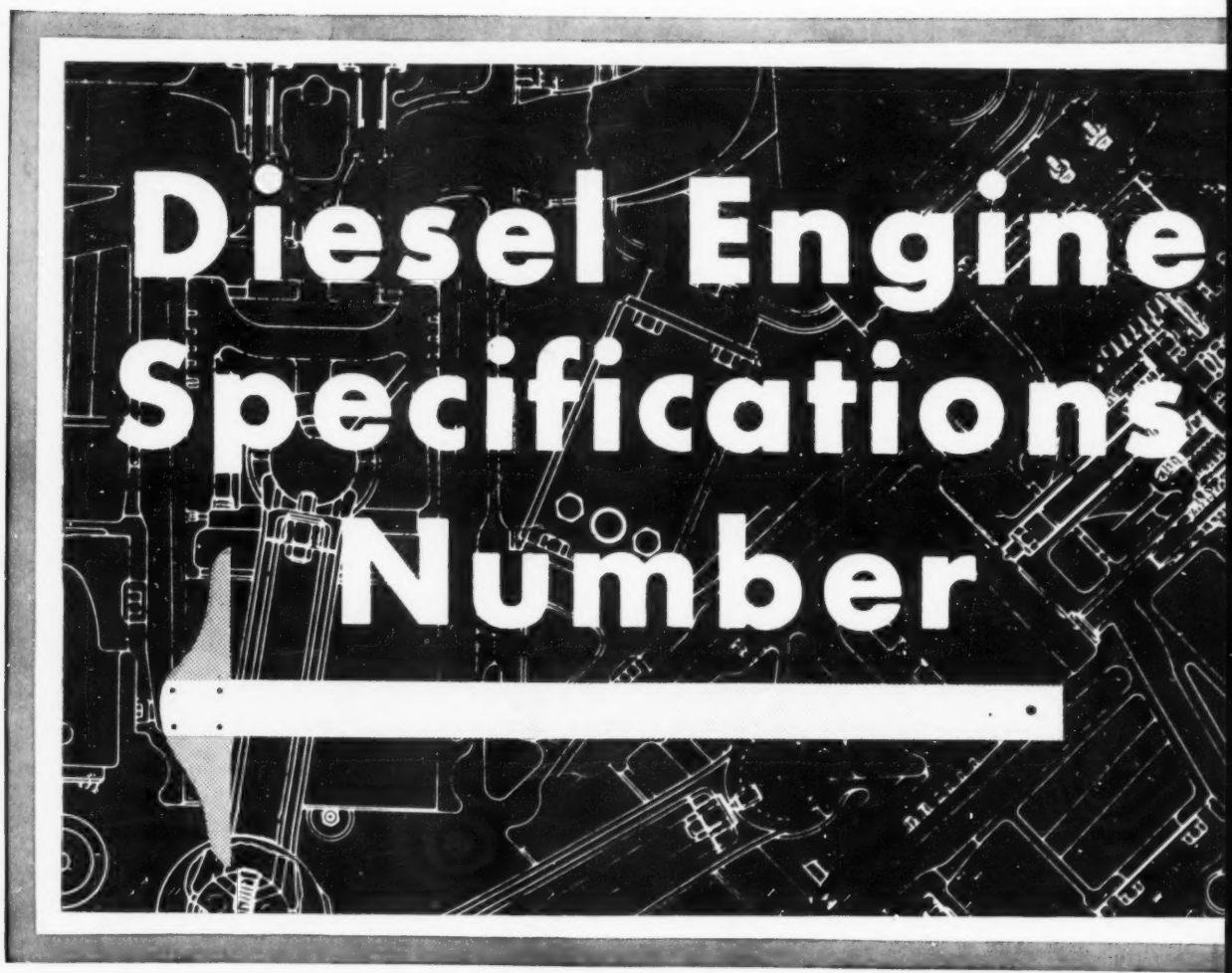
DIESEL POWER

AND DIESEL TRANSPORTATION

APRIL, 1953



- *Two Years With Bunker "C" Fuel*
- *New York Central Investigates . . . Diesel Wheel Slip and Slide*

NO STUCK RINGS IN 117,935 ENGINE

This Nordb lubricat TEXACO

WA PAC

For a real "workhorse" we give you this 1500 h.p. Nordberg Diesel in the Sioux Falls, S. D., municipal power plant. It has been in service 96% of the time for 14 years, running up a total of 117,935 engine hours. Says A. T. Hanson, Chief Engineer –

"We *have* to have effective lubrication to maintain our operating schedule. The efficacy of *Texaco Ursa Oil* in this engine is indicated by the fact that we have never found a stuck ring and – even after 117,935 engine hours – all but one of the engine's original cylinder

impressively low – an average of 4,855 h.p. hours per gallon of *Texaco Ursa Oil* for the last year reported.

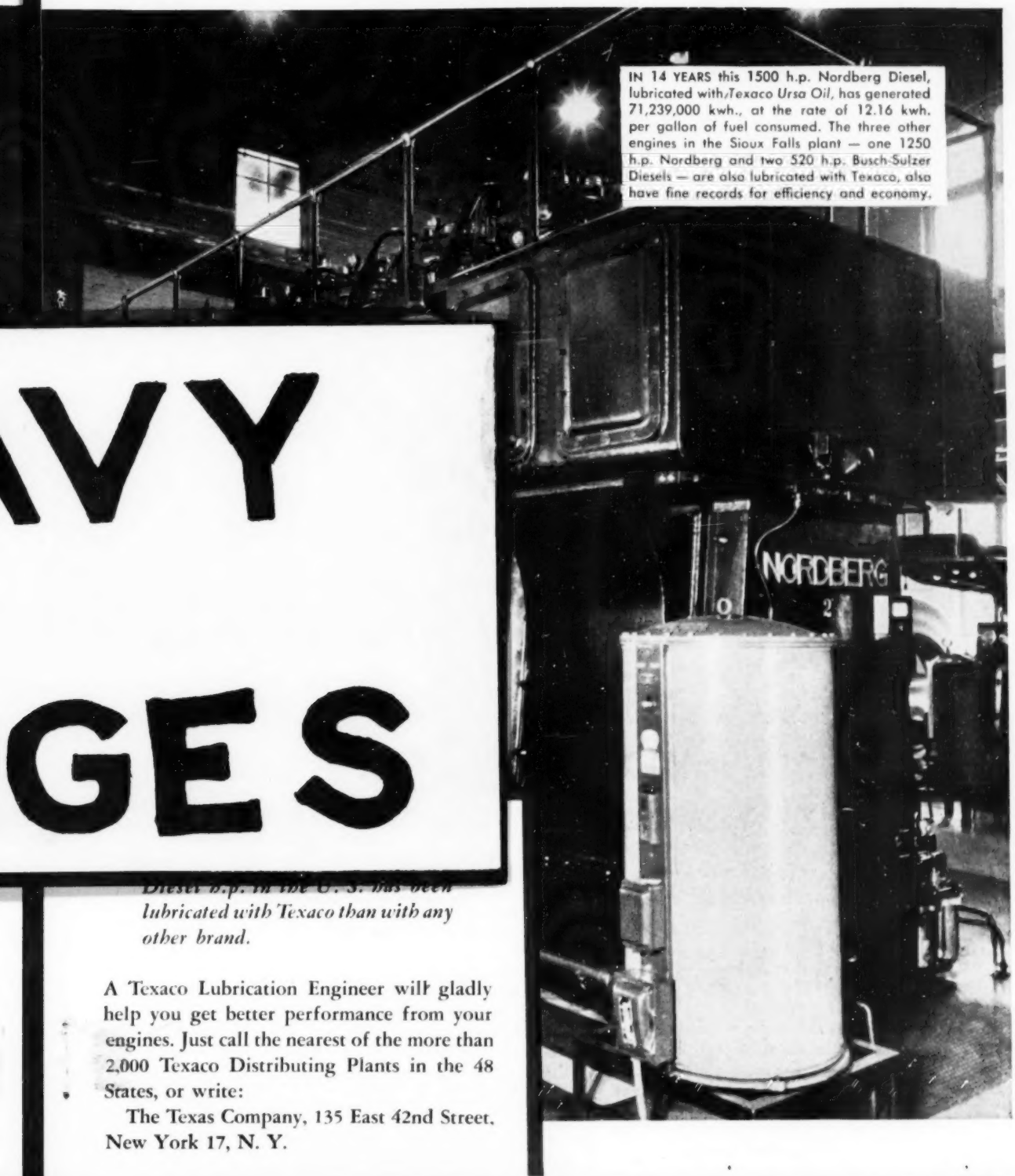
Everywhere, *Texaco Ursa Oil* keeps efficiency high, maintenance costs and fuel consumption low. There is a complete line of *Texaco Ursa Oils* to assure top performance from Diesel, gas and dual-fuel engines. They are approved by leading engine builders and preferred by operators. In fact –

TUNE IN . . . TEXACO STAR THEATER starring MILTON BERLE, on television Tuesday nights. **METROPOLITAN OPERA** radio broadcasts Saturday afternoons.

TEXACO

TEXACO

DIESEL POWER and DIESEL TRANSPORTATION for April 1953, Vol. XXXI, No. 4. It is published monthly by Diesel Publications, Inc., Orange, Conn. Executive and Editorial offices at 192 Lexington Ave., New York 16, N. Y. Subscription rate: United States, $3.00 per year, single copies 35¢; Canada $4.00. Foreign $5.00 per year. Entered as second class matter April 29, 1949 at the Post Office, Orange, Connecticut under Act of March 3, 1879.



IN 14 YEARS this 1500 h.p. Nordberg Diesel, lubricated with Texaco *Ursa Oil*, has generated 71,239,000 kwh., at the rate of 12.16 kwh. per gallon of fuel consumed. The three other engines in the Sioux Falls plant — one 1250 h.p. Nordberg and two 520 h.p. Busch-Sulzer Diesels — are also lubricated with Texaco, also have fine records for efficiency and economy.

AVY

GES

Diesel h.p. in the U. S. has been lubricated with Texaco than with any other brand.

A Texaco Lubrication Engineer will gladly help you get better performance from your engines. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

URSA OILS FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

NO STUCK RINGS IN 117,935 ENGINE HOURS

This Nordberg Diesel lubricated with TEXACO URSA OIL

For a real "workhorse" we give you this 1500 h.p. Nordberg Diesel in the Sioux Falls, S. D., municipal power plant. It has been in service 96% of the time for 14 years, running up a total of 117,935 engine hours. Says A. T. Hanson, Chief Engineer –

"We *have* to have effective lubrication to maintain our operating schedule. The efficacy of *Texaco Ursa Oil* in this engine is indicated by the fact that we have never found a stuck ring and – even after 117,935 engine hours – all but one of the engine's original cylinder liners are still in service."

In addition, lube oil consumption has been impressively low – an average of 4,855 h.p. hours per gallon of *Texaco Ursa Oil* for the last year reported.

Everywhere, *Texaco Ursa Oil* keeps efficiency high, maintenance costs and fuel consumption low. There is a complete line of *Texaco Ursa Oils* to assure top performance from Diesel, gas and dual-fuel engines. They are approved by leading engine builders and preferred by operators. In fact –

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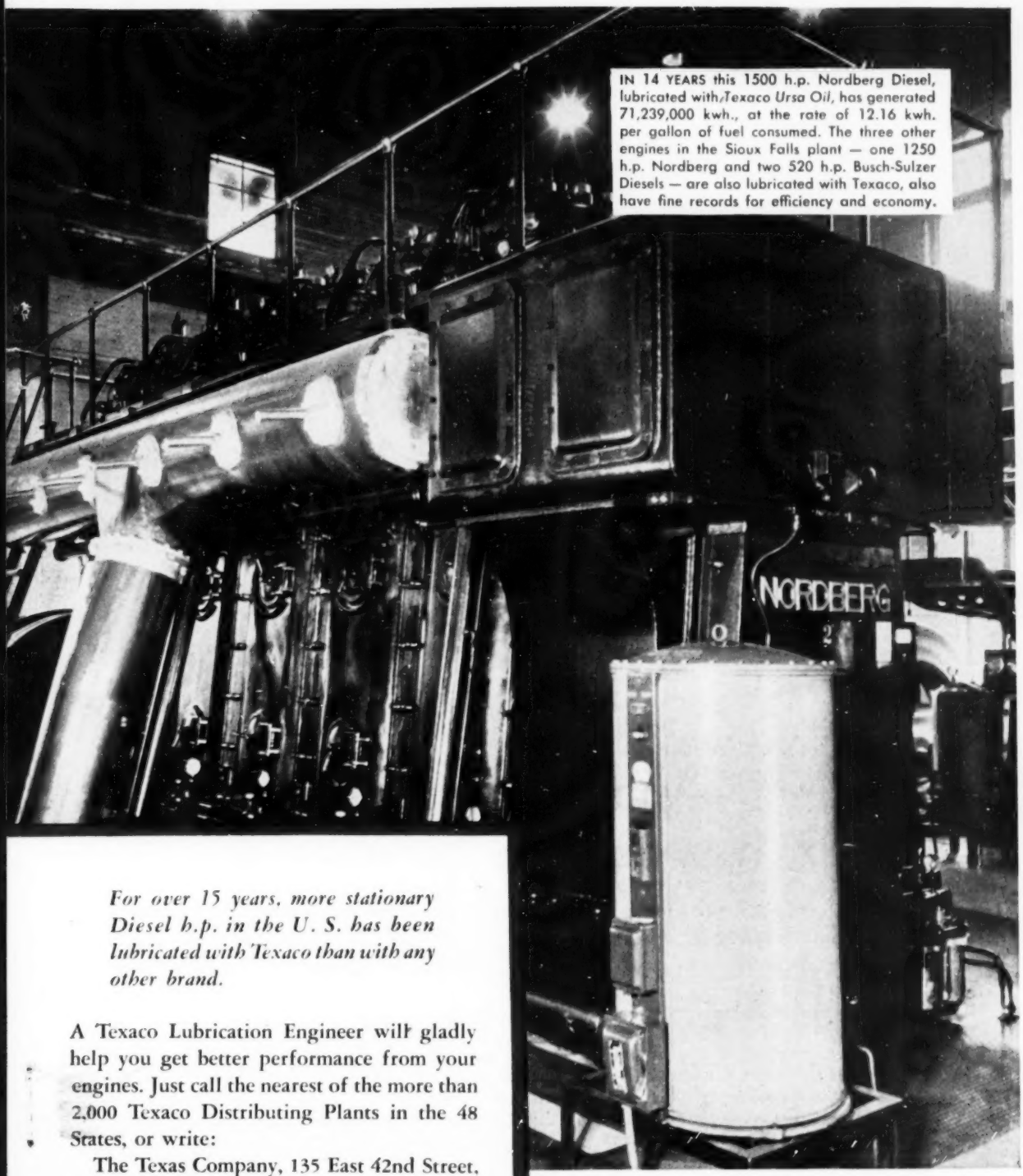

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For over 15 years, more stationary Diesel h.p. in the U. S. has been lubricated with Texaco than with any other brand.

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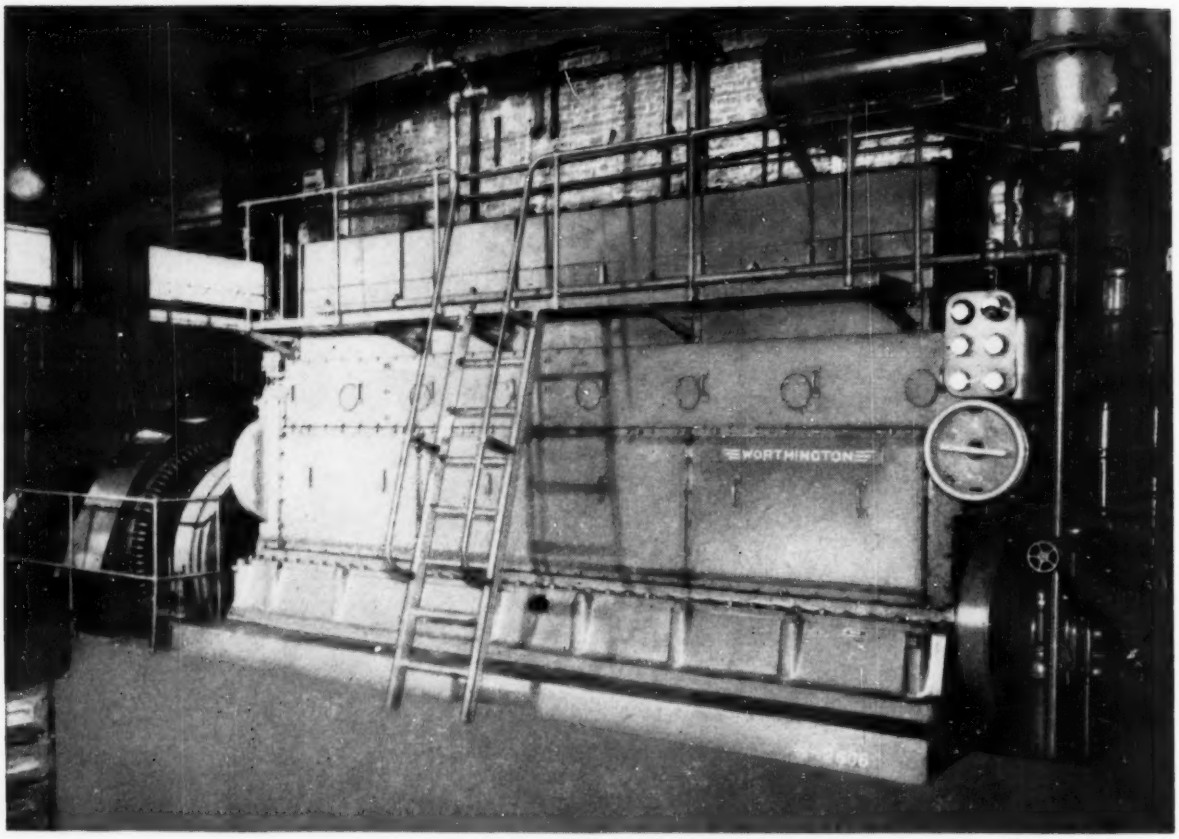
URSA OILS FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES



WORTHINGTON 1085-KW DIESEL ENGINE, is one of three Worthington engines now serving at Ford City, Pa., municipal power plant. This engine, during first 2 years of operation, logged 16,490 hrs. with average lube oil consumption of 5,400 hp hrs per gallon.

Ford City, Pa.—Another "repeat" customer of Worthington Diesels

Borough officials take pride in power plant's operating economy during 16 years

Sixteen years have passed since the first Worthington Diesel was installed in the municipal power-generation plant at Ford City, Pennsylvania.

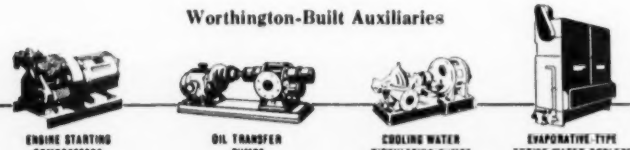
The latest installation—made in 1948—is a Worthington 1085-kw Diesel generator set. Other Worthington performers in the plant are the 300-kw unit installed in 1936 and the 462-kw unit installed in 1938.

Borough officials and the plant manager—who pride themselves on operating economy—tell us they now take for granted the dependability of their Worthington engines. Local consumers—some 6,000—have the low consumption of fuel oil and lube oil, as well as low maintenance expense, to thank for their economical rates.

Worthington's complete line of engines can give your municipal installation the most economical power no matter what fuel is used. For more data on modern Worthington engines—gas, Diesel, or dual-fuel—write Worthington Corporation, Engine Division, Buffalo, N. Y.

E.2.4

Worthington-Built Auxiliaries



ENGINE STARTING COMPRESSORS | OIL TRANSFER PUMPS | COOLING WATER CIRCULATING PUMPS | EVAPORATIVE-TYPE ENGINE WATER COOLERS

Economical Continuous Power—Diesel Engines, 150 to 2,100 hp . . . Gas Engines, 190 to 2,100 hp . . . Dual Fuel Engines, 150 to 2,100 hp.

WORTHINGTON
Engines

VN

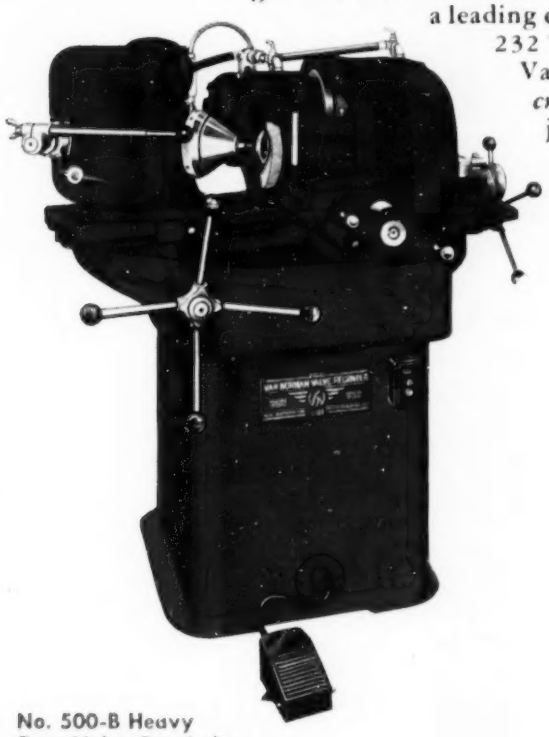
Cost Records Prove . . .

VAN NORMAN EQUIPMENT

is the least expensive equipment because it's the best you can buy

GET IT FROM YOUR JOBBER

"With these machines added to our numerous other Van Norman machines, we give topnotch service to our large clientele. Our increasing sales are ample evidence of the very good service these machines enable us to render." So says a leading engine rebuilder, about his No. 232 "Pin Shop" and his No. 500-B Valve Regrinder. *And they'll increase sales for you, too!* See your jobber or write Van Norman Co., Springfield 7, Mass.



No. 500-B Heavy Duty Valve Regrinder

. . . regrinds valves up to 1" stem diameter, also push rods, con-rod caps, valve stem ends, rocker arms.

No. 232 "Pin Shop"

reconditions rods, fits pins to rods, then fits pins to pistons, faster and more accurately than any other method.

The Best-Equipped Shop Gets the Business! That's why *"It Pays to Van Normanize"*

THE NEW
Exide
XF BATTERIES

For sure-fire

For diesel-powered equipment

No starting headaches, no lost time—on or off the highways—when you use Exide XF batteries. They assure quick breakaway and fast acceleration of engine to firing speed. The Exide XF is the best diesel-starting battery that even Exide has ever made. The new Exide XF sets a new high standard of economy and performance.

WITH XF BATTERIES YOU GET:

EXTRA LONG LIFE. Longer than you ever thought possible.

QUICK BREAKAWAY and fast acceleration of engine to firing speed.

RUGGED CONSTRUCTION for rough usage in hard service.

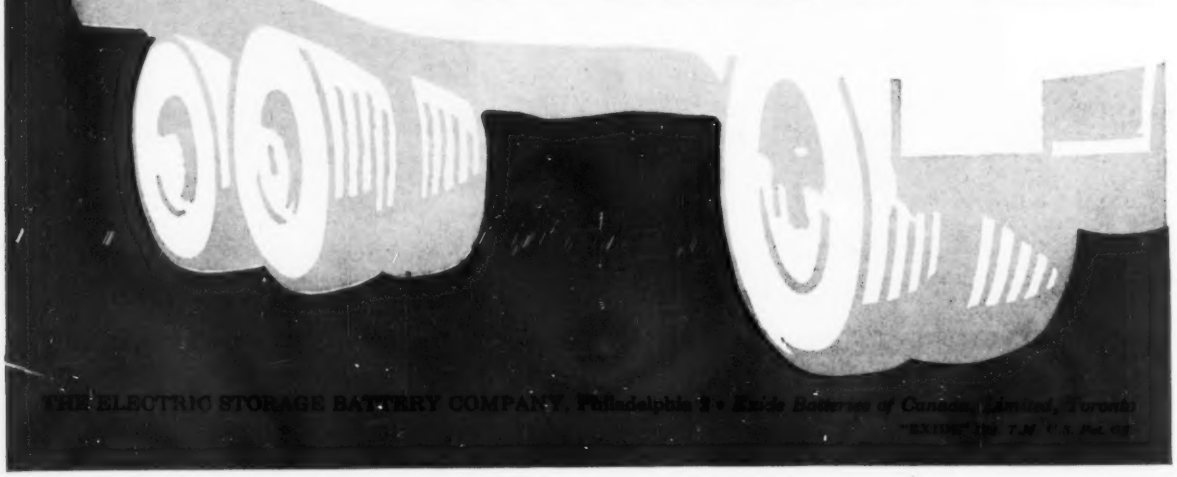
LOW COSTS of operation and maintenance.

OUTSTANDING FEATURES:

- **New grid alloy**
- **New active material—G.O.X.**
- **Lower gravity electrolyte**
- **New dual insulation**

Now, more than ever before

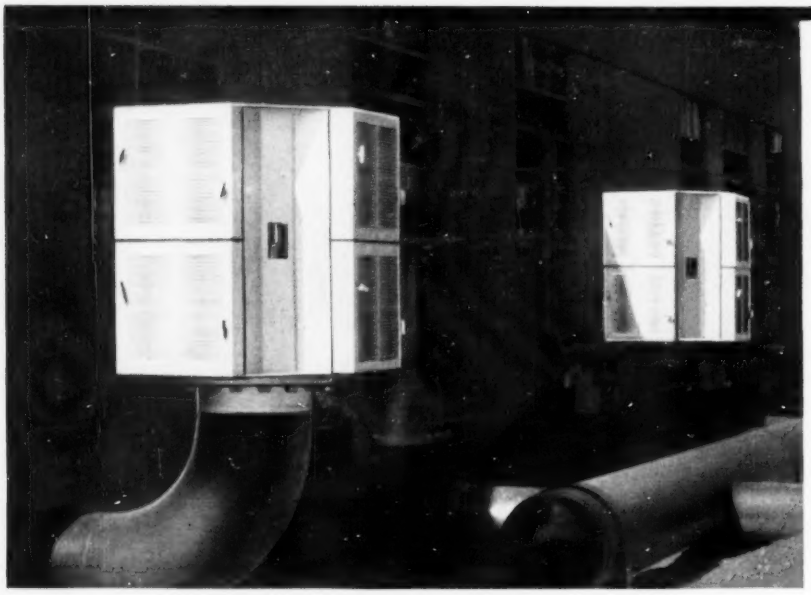
EXIDE IS YOUR BEST BATTERY BUY . . . *AT ANY PRICE*



THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 2 • *Exide Batteries of Canada, Limited, Toronto*

DIESEL-STARTING

GUARD THE INTAKE and CUT YOUR OUTGO!*



*AAF "OC-H" Filters Eliminate Costly Repairs and Time Losses Due to Dust Damage

You're actually "piping trouble" to your engines and compressors when you fail to properly filter the air at the intake. The result is always the same—always costly—major repairs accompanied by important production losses.

Nor does the presence of just any filter at the intake guarantee protection. If it's doing a job short of perfection, you are merely delaying your troubles. That's why AAF's Type "OC-H" Air Intake Filter is a favorite in the field. This washable unit-type filter combines high cleaning efficiency with low resistance to air flow and large dust holding capacity. Its first cost is low, and sturdy construction assures long, trouble-free operation.

Don't let "dust protection" be an afterthought in your planning. AAF's complete line of Air Intake Filters permits the selection of the most economical and efficient unit for handling your specific dust loads. Write us today for complete catalog information.

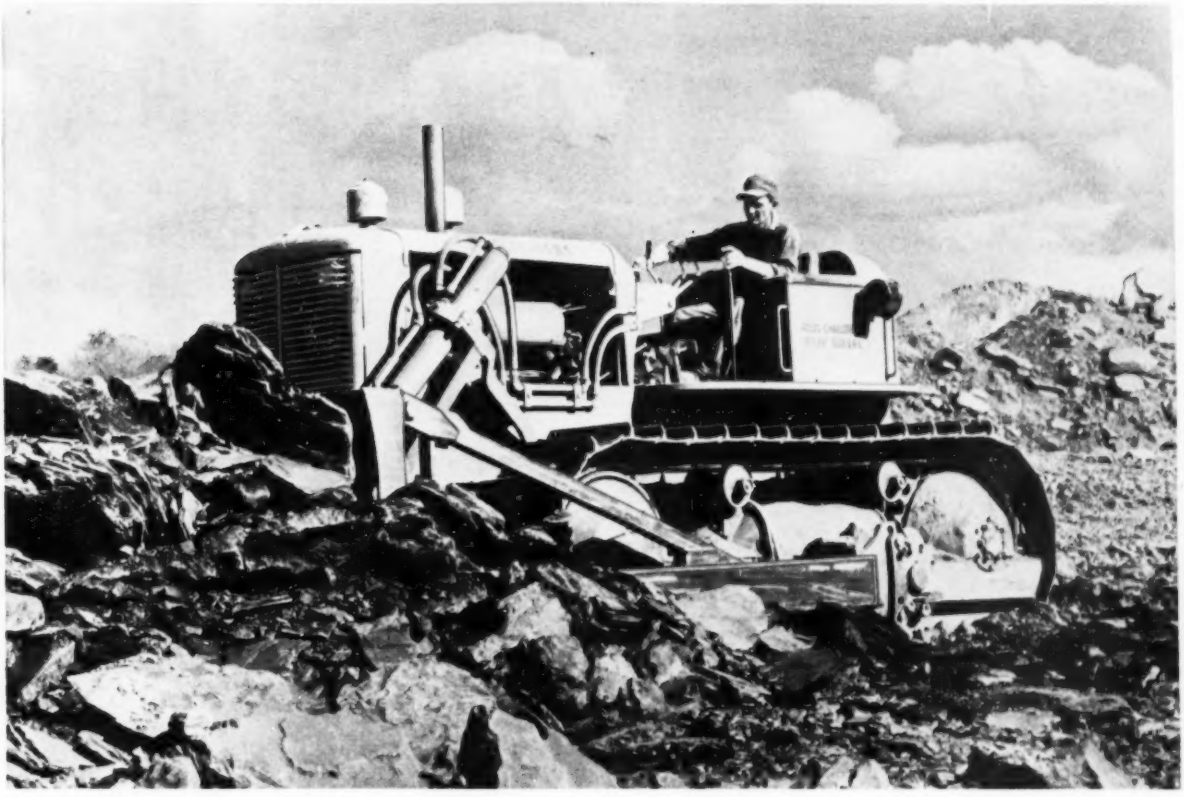
AAF

American Air Filter

COMPANY INC.

445 Central Avenue, Louisville 8, Kentucky • American Air Filter of Canada, Ltd., Montreal, P. Q.

SWITCH TO GM DIESEL



HERE'S WHY IT GETS WORK DONE FASTER!

IF SIX MEN all tugged on a rope at once, they could pull more than if only three tugged and three rested. That's the way the General Motors 2-cycle Diesel engine in this tractor works. *Every* cylinder produces power *every* revolution of the crankshaft—*twice* as many power strokes per crankshaft revolution as in 4-cycle Diesels.

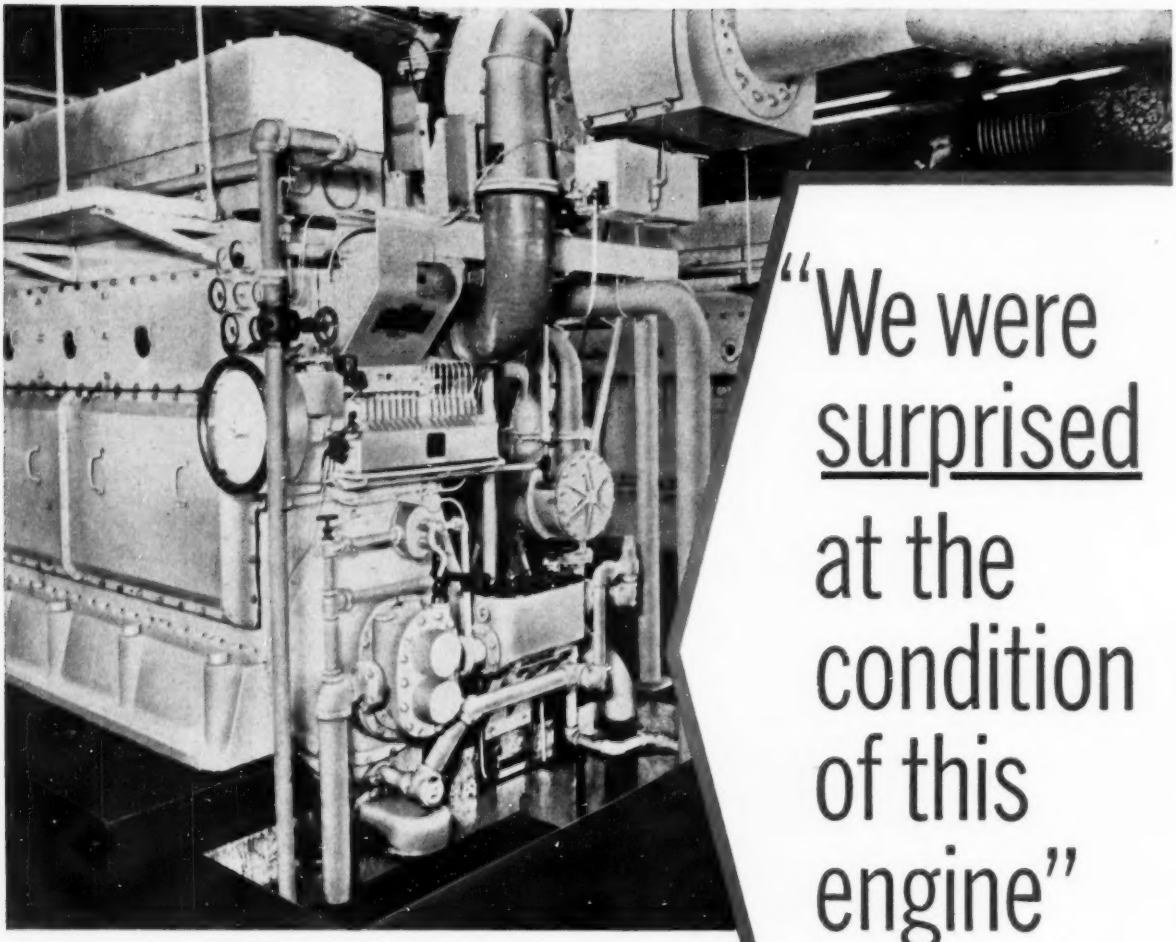
This GM Diesel feature helps give construction equipment the ability to get work done faster. In Allis-Chalmers' HD-9's and HD-15's, for example, when tough going has reduced travel speed 40% the tractor will have *increased* drawbar pull almost 20% over rated pull. Travel speed has to drop 45% before drawbar pull even begins to fall off. The tractor ties into a load faster and "hangs on" to it longer. *This means more work done, more dirt moved every shift!*

This is another way of telling you why more and more contractors are switching to GM Diesel-powered equipment to speed production and cut costs. GM Diesels are available in more than 750 models of equipment built by 150 different manufacturers. It will pay you to specify GM Diesel power for your machines.

Single Engines . . . 16 to 275 H. P. Multiple Units . . . Up to 840 H. P.

GM GENERAL MOTORS DIESEL POWER

DETROIT DIESEL
ENGINE DIVISION
GENERAL MOTORS • DETROIT 28, MICHIGAN



"We were surprised at the condition of this engine"

... says G. V. Yarger,
Supt. Municipal Utilities
Waverly, Iowa

"When we finally opened up our Worthington, it was in the *best* condition I've ever seen a diesel engine that had operated such long hours and under such heavy loads as this unit. It had a total of 48,926 hours on it – 8,987 hours of tough operation since the last overhaul.

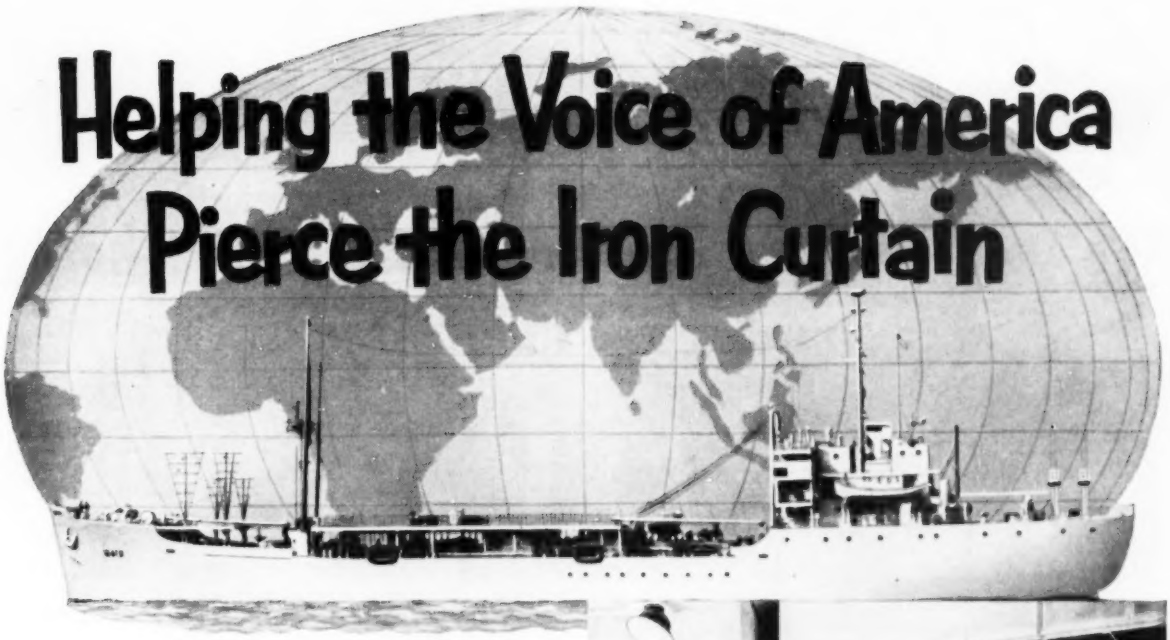
Mr. Yarger continues, "We've been using Sinclair RUBILENE® Heavy in the crankcase and RUBILENE H.D. 30 in the cylinder lubricator. These RUBILENES have kept the crankcase and upper portions of the cylinders exceptionally clean and bright, with no sign of carbon or deposits."

That's a typical report on the exceptional qualities of the Sinclair RUBILENES . . . evidence that they could improve the efficiency of *your* diesels, too. Why not switch now? Contact your nearest Sinclair Representative or write Sinclair Refining Company, 600 Fifth Avenue, New York 20, N. Y.

SINCLAIR DIESEL OILS

save wear and replacements

Helping the Voice of America Pierce the Iron Curtain



In a separate new auxiliary engine room, on the U.S. Coast Guard Cutter *Courier*, three 725 h.p. Enterprise diesels with Bendix* Fuel Injection equipment are playing an important part in helping to fight the cold war.

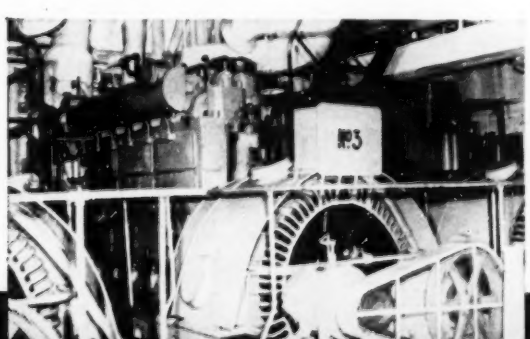
For this is the power plant that helps to transmit the Voice of America through the Iron Curtain to the captive peoples of the world.

To provide the electric power for the big transmitters, generating facilities must be capable of carrying difficult, variable loads with unvarying frequency, efficiently and dependably. Furthermore, the Enterprise diesels must continue to operate even if no better oil is available than residual fuel.

To help accomplish this important yet difficult task, Bendix Fuel Injection equipment was selected. In fact, wherever unusual performance standards are required, there is no better choice in fuel injection equipment than Bendix for complete dependability.

*REG. U.S. PAT. OFF.

Main transmitter room from which programs can be initiated or Voice of America broadcasts from land based points can be relayed out again with greatly amplified range and power.



Power for the 150,000 watt medium wave transmitter and two 35,000 watt short wave transmitters is supplied by three Enterprise diesel engines with Bendix Fuel Injection equipment.

SCINTILLA MAGNETO DIVISION of

Bendix
AVIATION CORPORATION
SIDNEY, NEW YORK

Western Market Office: 582 Market Street, San Francisco, Calif.
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

BEST... again and again!

A leading Diesel manufacturer reports:

We were getting bearing failure in 100 hours ...until we standardized on

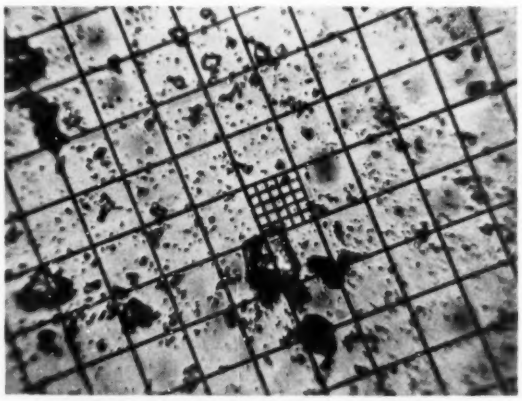
PUROLATOR

FULL-FLOW

MICRONIC FILTERS

In service so severe that engine bearings formerly failed in a hundred hours or less—the same Diesel equipment now operates more than a thousand hours with no visible bearing wear!

This enormous increase in bearing life—this Diesel manufacturer reports—can be credited entirely to Purolator Full-Flow Micronic* filtration. Needless to say, Purolators are now standard equipment on *all* this manufacturer's Diesel vehicles and industrial engines!



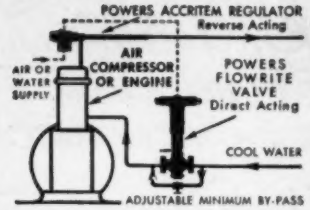
The Purolator* Micronic element traps dirt down to *submicrons* in size, and has many times more *dirt storage space* than old-style filters.

Not once . . . not twice . . . but *every time* Purolators have been tested by the world's largest and most important makers of internal combustion engines—Purolators have won top honors. No other filter is capable of delivering the high flow rates necessary for filtering *all* the oil at *each* pass—full-flow filtration—with minimum pressure drop throughout a lengthy service life. And no other filter gives dependable filtration down to *submicrons* (.0000039 in.)! The Micronic element has *ten times* the effective filtering area of old-style filters. And—size for size—no other filter provides as much *dirt storage space* as does Purolator.

Want to prove Purolator's outstanding superiority to your own satisfaction . . . on your own equipment . . . in your own way? Our Engineering Department will gladly co-operate in helping you conduct any type of comparative filter test you may prefer. Simply write, describing your equipment. *Reg. U. S. Pat. Off.

PUROLATOR PRODUCTS, INC.
Rahway, New Jersey and Toronto, Ontario, Canada
Factory Branch Offices: Chicago, Detroit, Los Angeles

PUROLATOR
MICRONIC OIL FILTER
"FIRST IN THE FIELD OF FILTERING"

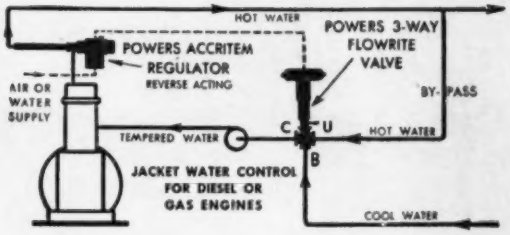


POWERS ACCRITEM REGULATOR

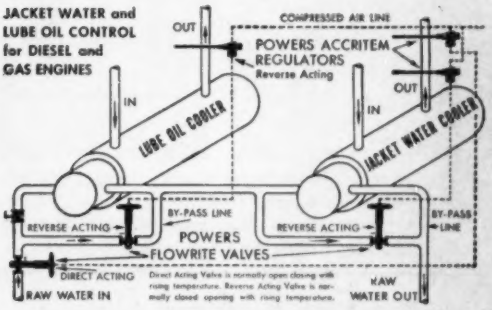
Easy to adjust

Compressed air or water operated

Unsurpassed for reliability and power to operate large or small size 3-way or 2-way diaphragm valves for accurate control of jacket water and lube oil cooling temperatures.



Only a few of many applications are shown here.



Gives Accurate, Low Cost Heat Control

Use Accritem Regulators to control diaphragm operated valves or dampers. They save labor, stop losses caused by over-heating and have the following —

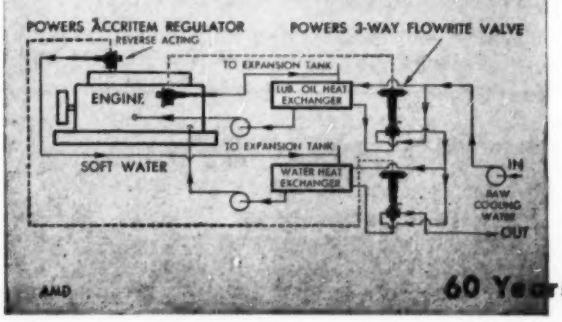
IMPORTANT ADVANTAGES

- ***Adjustable Sensitivity*** and over-heat protection.
- ***Calibrated Dial*** temperature adjustment.
- ***Simple, Rugged Construction*** withstands vibration and insures many years of reliable service.
- ***Temperature Ranges*** 50 to 250° F. and 150 to 350° F.
- ***Easy to Install*** Requires 15 lb. supply of compressed air or water for its operation.
- ***Small Size*** — regulator head is only 2⅞" x 3⅝", sensitive bulb is 12" long with ½" I.P.S. connection.

Proper Cooling Temperatures assured by Powers Accritem Regulators

• Makes ignition easier • Prevents rapid breakdown of lube oil • Decreases cylinder and piston ring wear • Reduces danger of piston seizure • Lowers fuel and lube oil consumption

FLOWRITE and METAFLOW Diaphragm Valves controlled by a POWERS ACCRITEM HEAT REGULATOR provide an unbeatable combination for *better control and lower maintenance*



Write for Bulletin 316 — or phone our nearest office for prices and further information about POWERS ACCRITEM regulators and diaphragm valves.

THE POWERS REGULATOR CO.

SKOKIE, ILL. • OFFICES IN OVER 50 CITIES • See Your Phone Book

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AMD **60 Years of Temperature and Humidity Control**

THE ENGINEER'S REPORT

DATA

LUBRICANT RPM Delo Oils

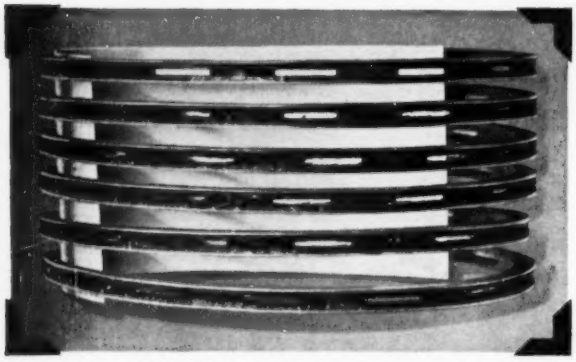
UNIT D-8 Caterpillar

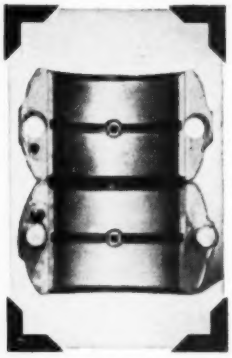
SERVICE Earthmoving contract work

CONDITIONS Heavy loads — dirt, dust

FIRM T. H. Walsh-Argo Engineering Company, Los Angeles

Engine parts "like new" after 7721 hours!





THIS SET OF OIL RINGS and the piston and con-rod bearing at right—all from a D-8 Caterpillar using RPM DELO Heavy Duty Lubricating Oil—appear just as they did when removed after 7721 hours of earthmoving work. There were no broken or stuck rings; the oil-return holes were open; all parts were free from deposits. The crankshaft was not more than 0.001 inch out of round at any point and was reinstalled.

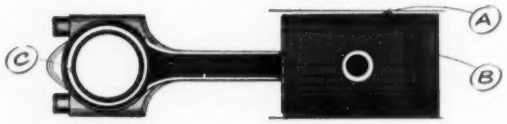
THE D-8 "CAT" above is the one from which the parts came. It is one of 11 large diesel tractors operated by the T. H. Walsh-Argo Engineering Co., Los Angeles. By using RPM DELO Oils, the company regularly gets 5000 or more hours between overhauls.

FREE BOOKLET on the RPM DELO Oils gives you complete information on how to meet any heavy-duty engine operating condition with one of these oils. Write or ask for it today.

RPM DELO LUBRICATING OILS

TRADEMARK "RPM DELO" REG. U.S. PAT. OFF.

How RPM DELO Oils reduce wear, corrosion, oxidation in all Heavy-Duty Engines



A. Contain special additives that provide metal-adhesion qualities...protect parts whether hot or cold, running or idle.

B. Anti-oxidant resists deterioration of oil and formation of lacquer...prevents ring-sticking. Detergent keeps parts clean...helps prevent piston scuffing.

C. Special compounds stop corrosion of any bearing metal and foaming in crankcase.

FOR MORE INFORMATION about this or other petroleum products of any kind, or the name of your nearest distributor handling them, write or call any of the companies listed below.

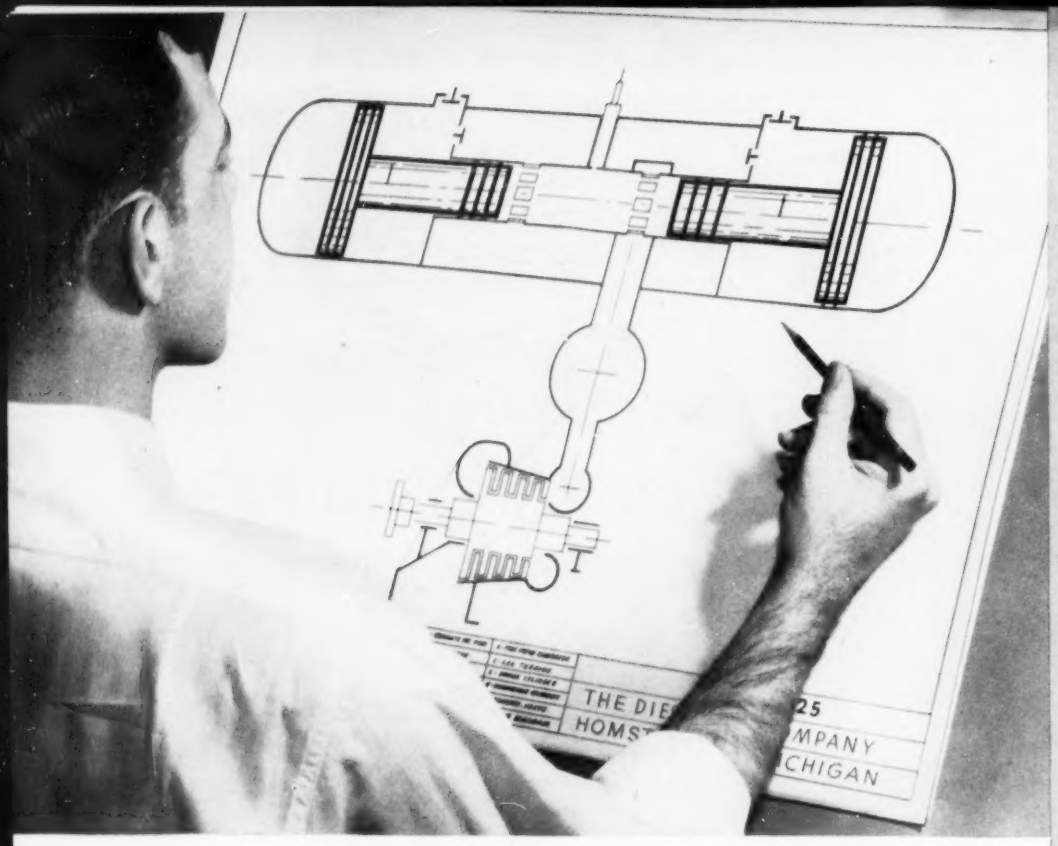
STANDARD OIL COMPANY OF CALIFORNIA, San Francisco 20 • STANDARD OIL COMPANY OF TEXAS, El Paso
THE CALIFORNIA OIL COMPANY, Barber, New Jersey • THE CALIFORNIA COMPANY, Denver 1, Colorado

WOULD YOU CLEAN ONLY PART OF YOUR FACE?

No, of course, you wouldn't! Then why clean only *part* of the oil in your engine? Why be satisfied with anything less than the best protection you can give your engine's moving parts? Keep *all* your oil clean, and all the moving parts of your engine protected, with warranted Winslow Full-Flow Filters!

WINSLOW FILTERS

Winslow Engineering Company 4069 Hollis Street • Oakland 8, California



Your new engine?

Use OHIO's service, and incorporate all the economies . . . machining and engineering . . . at the start . . .

OHIO offers you an extraordinary PISTON service. Help in developing designs to meet the tougher conditions imposed by tomorrow's engines—then help in taking those designs out of the laboratory and putting them into production; OHIO PISTON service is that complete.

Available to you, through OHIO, are the best facilities of the country's leading piston casting producer. Their engineers and ours will work with you to turn theoretical pistons into real ones. You will get the best in engineering—and the lowest machining cost—in one package.

While your new engine is still on the drawing board, tell us what you expect of its pistons. Then piston performance and production will be proved well ahead of time for your assembly line. For this help, get in touch with The Ohio Piston Company, 5340 Hamilton Avenue, Cleveland 14, Ohio.

Aluminum Pistons
Cast Iron Pistons
Piston Pins
Cylinder Sleeves
Sleeve Assemblies
Oil Seals, Caps, Guides
Related Parts

THE OHIO PISTON COMPANY

Cleveland, Ohio

STAYNEW INTAKE FILTERS GIVE

GREATER EFFICIENCY

plus

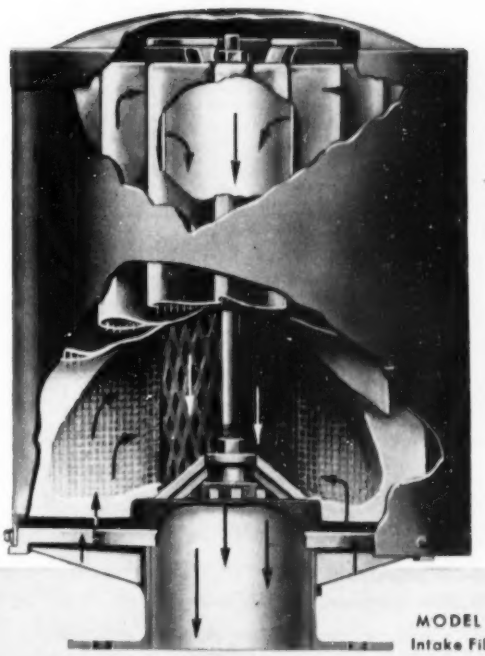
POSITIVE PROTECTION

IT'S A FACT! A filter which is 99.9% efficient is *9 times* as effective as one that is 99.0% efficient. Why?—because the filter that is 99.9% efficient lets only *one-ninth* as much dirt into the engine. And, it's the dirt that *gets in* that causes the trouble.

The extreme efficiency of Staynew Intake Filters provides *positive protection*—keeps shutdowns and repairs at an absolute minimum. Efficiency actually increases with use. Staynew Intake Filters are efficient over a wide range of loads and are not affected by temperature changes. And, Staynew Intake Filters effectively protect vital engine parts without carefully held maintenance schedules . . . frequently operating two or more *years* without attention.

Get all the facts. Write today for Bulletin S.I.F.

Representatives in Principal Cities



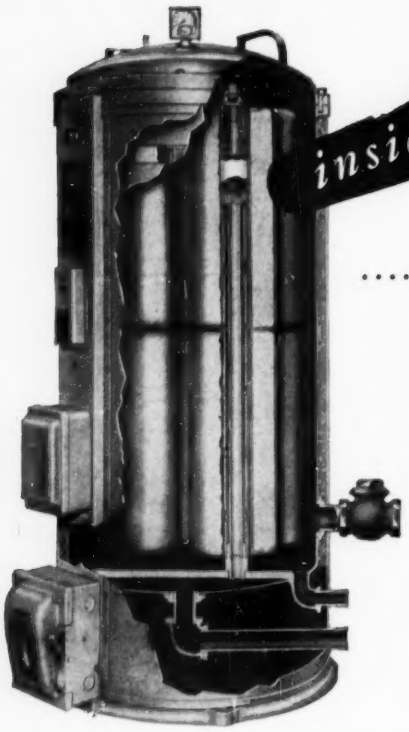
MODEL D
Intake Filter

DOLLINGER
STAYNEW FILTERS

DOLLINGER CORPORATION

10 Centre Park, Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED



inside tip...

HONAN-CRANE

only

DIESEL OIL PURIFIERS

give you so many

VITAL ENGINEERING FEATURES

The Honan-Crane "Multi-Cartridge" Purifier is engineered, *inside and out* to provide the high-flow, *thorough* oil purification essential for diesels. Removes *all types* of harmful contamination . . . substantially reduces engine wear and maintenance costs . . . quickly pays for itself in oil savings alone!

Here are a few of the time-tested features that make Honan-Crane preferred for *safety and savings* by engineers and operators wherever diesels are used:

1 Filtering and purifying cartridges are readily interchangeable to provide type and degree of purification required by oil condition . . . either additive or straight mineral oils. See description of cartridges below.

2 Clean oil is drawn from *top* of purifier after passage through purifying medium . . . thus utilizing maximum filtering efficiency of each cartridge. False oil levels and drain-back are avoided.

3 Cartridge construction assures even penetration of oil, prevents channeling or by-passing. Multiple unit design permits thorough purification at high flow rate essential for diesels.

4 Low watt density heater bands maintain oil at correct temperature for smooth flow through purifying medium. Steam or hot water heating available if specified.

5 Positive oil and gas-tight seals and gaskets prevent seepage of oil or fumes. Dirty oil cannot contaminate clean oil passages.

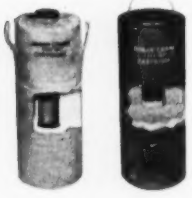
6 Double-decked cartridges save floor space, permit clean design greater operating efficiency.

7 Positive locks and strong pressure springs keep cartridges firm and securely in place. No channeling between cartridges.

8 Purifier is fully equipped with automatic controls, pressure gauge and safety features. Requires no attention except periodic renewal of cartridges.

INTERCHANGEABLE CARTRIDGES FOR HONAN-CRANE MULTI-CARTRIDGE PURIFIER

TYPE "MC" TYPE "MF"



TYPE "MC" Cotton bag packed with fuller's earth. Removes *products of oxidation . . .* acids, gums, etc. Keeps neutralization & steam emulsion numbers within desired limits. Provides refinery-type purification.

TYPE "MF" Perforated metal basket packed with cellulose fiber. Recommended for additive oils for complete removal of *solids* such as dirt, abrasives, scale and other foreign matter. Will not remove or affect inhibitors.

TYPE "S" contains cellulose fiber packed in cotton sock material. Performs same filtering functions, same efficiency as Type "MF" Cartridge. Fiber center tube simplifies disposal of spent cartridge by burning.

TYPE "E" is similar to Type "S," except that filtering material is cotton waste and excelsior. Type "E" is recommended when water is encountered in the oil.

TYPE "S" TYPE "E"

Honan-Crane Fuel and Lube Oil Purifiers are available for any size or make of Diesel Engine

Take advantage of Honan-Crane's many years of experience in providing positive, dependable purification of diesel oils. For detailed information and help, write Honan-Crane giving make, model and H.P. of your diesel . . . describing any unusual aspects of your particular oil purification problem.

ALL HONAN-CRANE EQUIPMENT IS SOLD ON A PERFORMANCE GUARANTEED BASIS

Mail this coupon for descriptive literature

HONAN-CRANE CORP.,
305 Wabash Avenue, Lebanon, Indiana

Please send me free literature describing Honan-Crane filtration and purification equipment for diesel fuel and lubrication oils.

Company Name.....

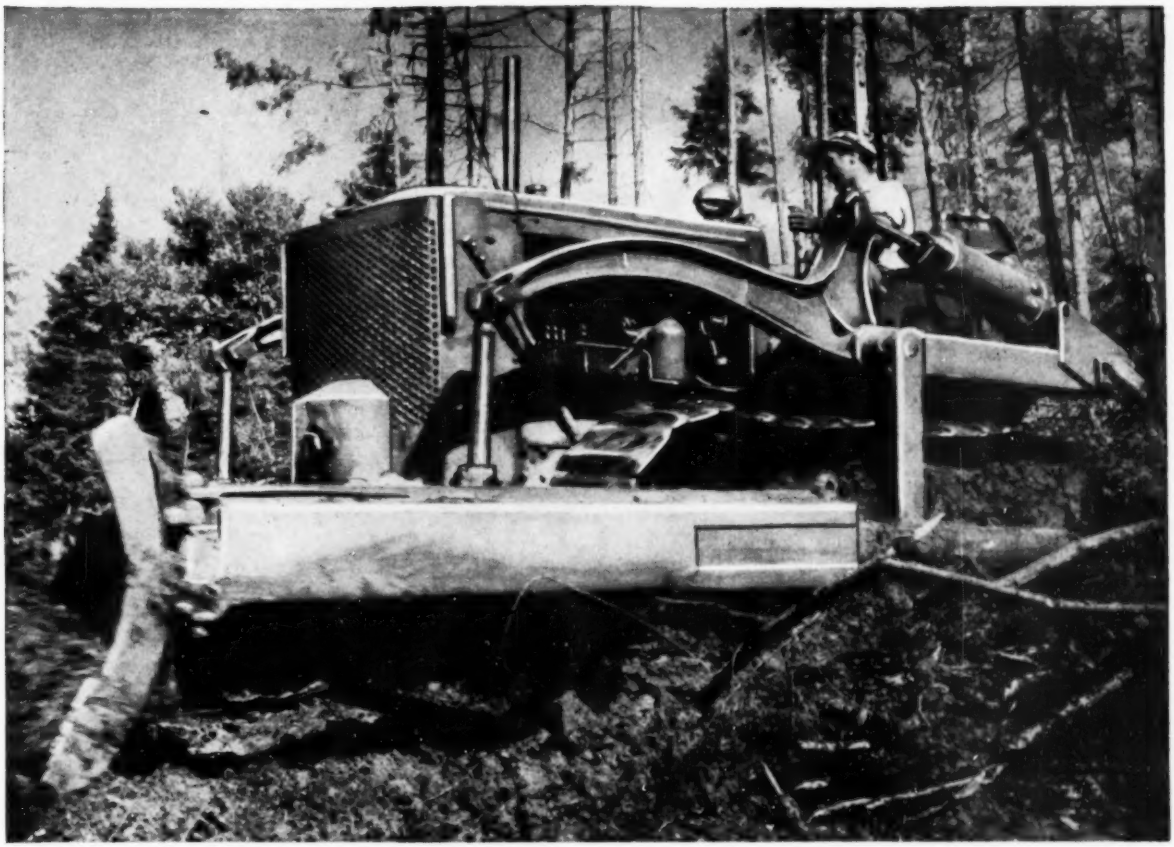
Address.....

City.....*State*.....

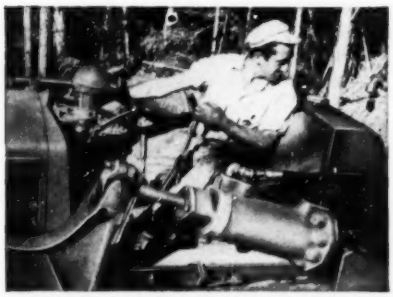
Your Name and Title.....

Honan-Crane Corp.
305 Wabash Avenue • Lebanon, Indiana
A Subsidiary of
Houdaille-Hershey Corp.

WORLD'S LEADING OIL FILTER MANUFACTURER



BESIDES CUTTING OUT ROADS, Riendeau uses his TD 14 to push his truck and a 15-ton load through quagmire road sections.



RIENDEAU HANDLES BULLDOZER HIMSELF. He says: "I've had first-hand experience with the terrific performance these highest quality Cities Service Products deliver."

New Hampshire Logger Cuts Truck Roads Through Forest!

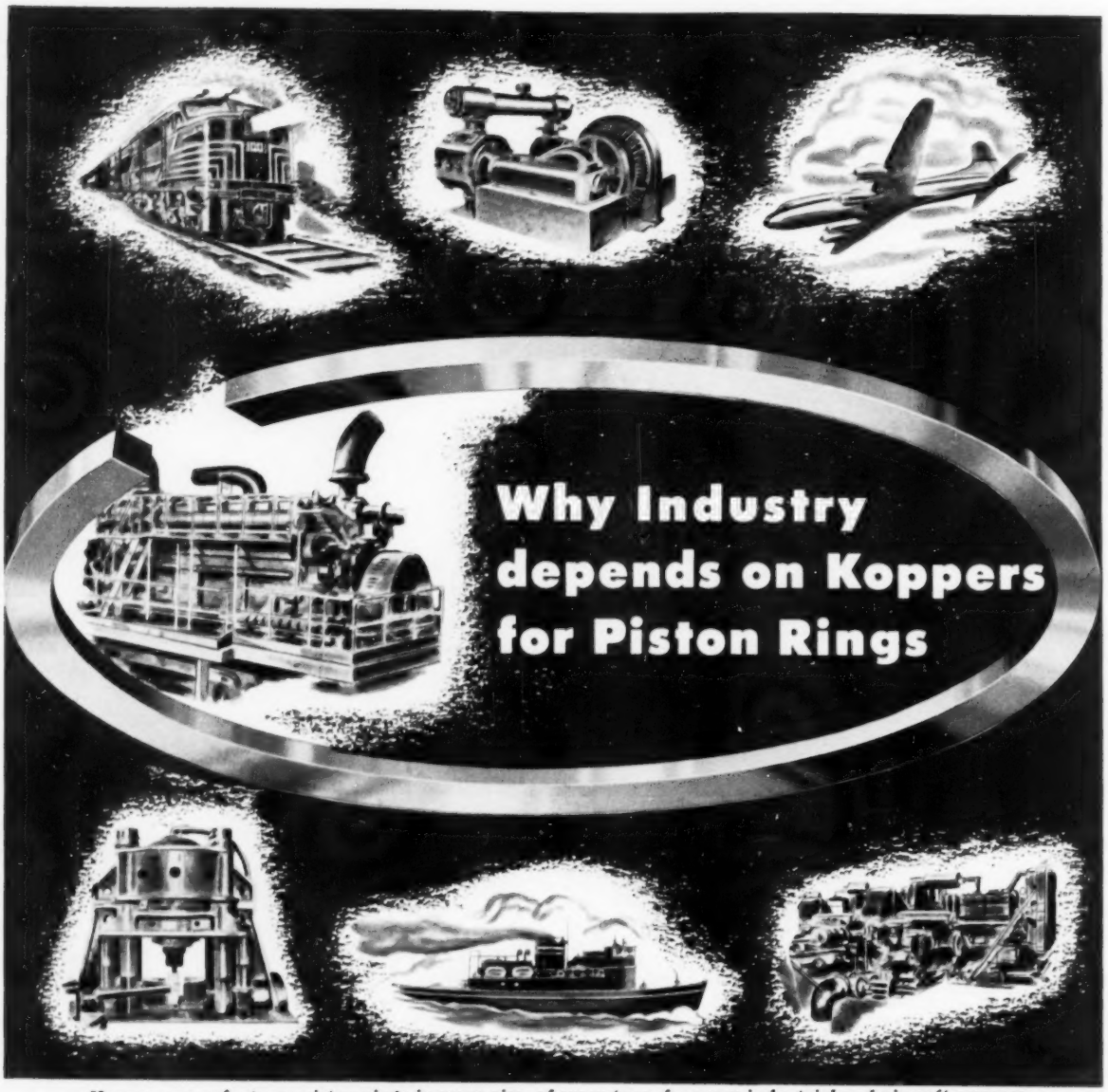
Oscar Riendeau of Berlin, N. H., has been hauling logs for about 15 years. To get his lumber out of densely overgrown New England forests, Riendeau has to cut his own truck roads. He carves out his twisting, turning truck roads with an International TD 14 Diesel . . . powered by Cities Service #2 Diesel Fuel! . . . lubricated with Cities Service Lubricants!

Says Riendeau: "I use Cities Service Products throughout my operation . . . diesel fuels, lubricants, gasolene, and even tires. These high quality, dependable products have kept my equipment at work full time under really rugged conditions. I heartily recommend them for any earth moving or trucking operation."

Why not try Cities Service Fuels and Lubricants in your operation?

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS



Koppers manufactures piston rings in every size, of every type, for every industrial and aircraft purpose.

FROM everywhere in industry come reports of savings in time, labor and money through the use of Koppers Rings in diesel and gas engines, hydraulic presses, compressors and other industrial equipment. That's because Koppers research and engineering keep up with modern advances in engine and equipment design by constantly improving piston ring materials and manufacturing methods.

Koppers K-Iron® Rings are made of a high-grade, closely-controlled material that imparts improved wear properties and is surface treated chemically as an anti-scuffing aid. They are made in diameters to 120" in a variety of joint types. Koppers Porous Chrome* Rings hold and distribute oil during break-in, quickly wear to best possible seating... *cut cylinder wear up to 50%, last 4 times as long as ordinary rings!*

Our engineers, who work with you in determining the best rings for your applications, have all the facilities of the large, modern Koppers piston ring plant at their disposal . . . to supply you with rings that cut down-time, increase efficiency and lengthen the life of your equipment.

WRITE, wire or phone us today for experienced help with your piston ring problems. KOPPERS COMPANY, INC., *Piston Ring Dept.*, 1544 Hamburg St., Baltimore 3, Md. *Van der Horst Process

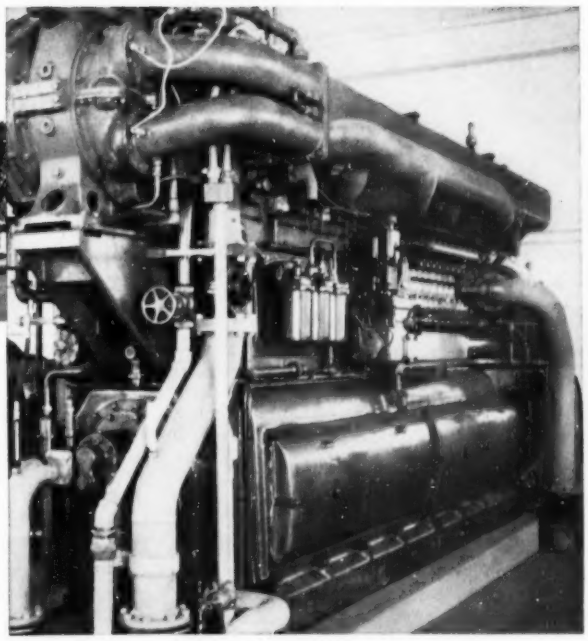
KOPPERS ®

Koppers American Hammered Industrial Piston Rings

Only **KOPPERS** *can furnish K-Spun® and Porous Chrome!*

165,000 hours of service completed by 28 Alco Diesels at 98½% availability

for Gulf Refining Company



Twenty-two years ago, Gulf Refining Company installed 28 Alco Diesel Engines on its new, 700-mile Tulsa-to-Spencerville Junction pipeline. Today, those 28 Alco Diesels have completed more than 165,000 hours of service and are operating at 98½% availability. And since 1941, when the output of the line was greatly increased, they have been in actual service an average of 97% of the time.

Pumping station superintendents throughout the United States and Canada specify Alco Standardized Diesels because of this kind of *proved* dependability——and because of these economy features:

- **Compactness**—for lower construction costs
- **Higher Engine Efficiency**—for lower fuel costs
- **Medium Speed**—for lower auxiliary equipment costs
- **Flexible Power Range**—for lower expansion costs

For the complete story on Alco Diesel Engines, contact your nearest American Locomotive Company Sales Office. You will find them in New York, Beaumont, Chicago, Cleveland, Houston, Kansas City, San Francisco, Schenectady and St. Louis.

ALCO DIESELS

THE MARK OF MODERN ENGINEERING

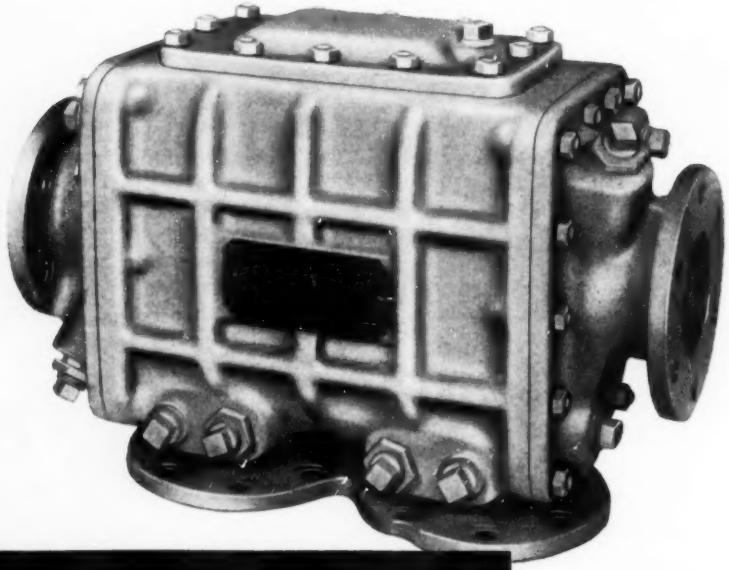
AMERICAN LOCOMOTIVE COMPANY

Heat Exchangers You Can Depend On

Harrison heat exchangers have the capacity, compactness and durability that Diesel engine manufacturers demand.

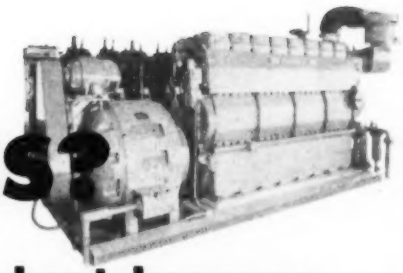
No matter what the application, Harrison heat exchangers do an efficient, dependable cooling job.

Because we have been building heat exchangers for a long time . . . because we have developed real know-how . . . we feel sure that we can be of service to you. Our representatives are as near as your telephone.



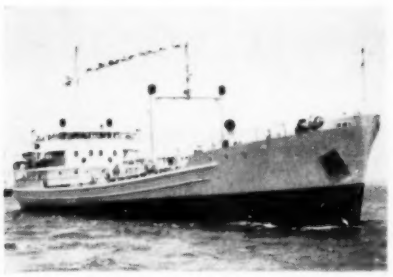
HARRISON
RADIATOR DIVISION
GENERAL MOTORS CORPORATION
LOCKPORT, NEW YORK

HARRISON



DIESELS?

D-X lubricates them best because only D-X contains EXTRINOL



MID-CONTINENT PETROLEUM CORPORATION
TULSA, OKLA.
Waterloo, Ia. Terre Haute, Ind. Omaha, Nebr.
Chicago, Ill. Minneapolis, Minn.

Extrinol is a complex group of chemicals added to all D-X Diesel Oils. And the ingredients that make up Extrinol are the most effective wear fighters science yet has found to combat the enemies of diesel engines: *oil foam, extreme pressure, corrosion, rust, combustion dirt and varnish, acids and oxidants.*

Thus, when you use a D-X Diesel Oil (D-X DHD Motor Oil, D-X Motor Oil S2, or Diamond T.B.D. Motor Oil) you're getting this 3-way protection:

1. The pure, solvent-refined mineral oil base of D-X armors surfaces inside the engine with protective lubrication.
2. The Extrinol additives in D-X Diesel Oils combat the by-products of combustion. These are the vapors, gases, moisture, and other wastes left over after the diesel fuel has fired in the cylinders. And Extrinol helps neutralize them.
3. To make sure serious damage cannot come from circulating left-over wastes through the engine, the Extrinol in D-X causes them to be surrounded in molecules of oil and held in suspension.

If you operate diesel engines and if you are located in the Middle West, you can have the benefits of Extrinol without spending any more for lubricating oil than you do now. This exclusive D-X Extrinol additive is an advantage that's yours at no extra cost.

MID-CONTINENT PETROLEUM CORPORATION
BOX 381, TULSA, OKLAHOMA

I would like to have the advice of a D-X Lubrication Engineer in doing a better job of diesel maintenance. I understand this does not obligate me in any way.

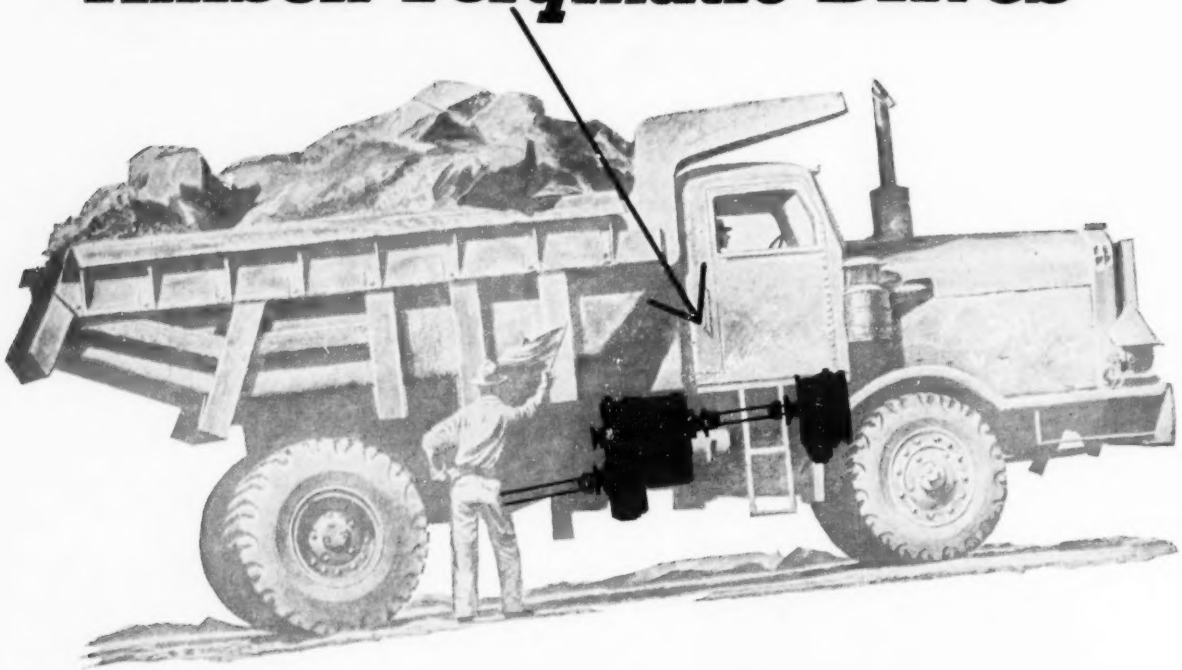
NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

Allison Torqmatic Drives



The Team that stretches time between overhauls!

Operators of heavy-duty, off-highway trucks soon find in their cost records that Allison TORQMATIC Converters and TORQMATIC Transmissions extend time between overhauls and help cut repair bills amazingly.

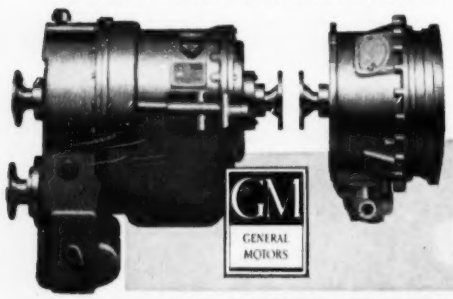
Allison TORQMATIC DRIVES match the engine power to the loads. Maximum engine horsepower can be utilized throughout the entire haul cycle, thus eliminating harmful shocks, lugging and stalling.

TORQMATIC DRIVES also cut operating costs because they take out much of the human element in driving the vehicles—gearshift guess and gearbox clash are things of the past. Allison TORQMATIC DRIVES "quick shift" hydraulically at full throttle by a flick of a simple control lever.

Send for the Allison pamphlet completely describing these Drives and learn more about their broad application to heavy-duty equipment.

ALLISON DIVISION OF GENERAL MOTORS
Box 894SS, Indianapolis 6, Indiana

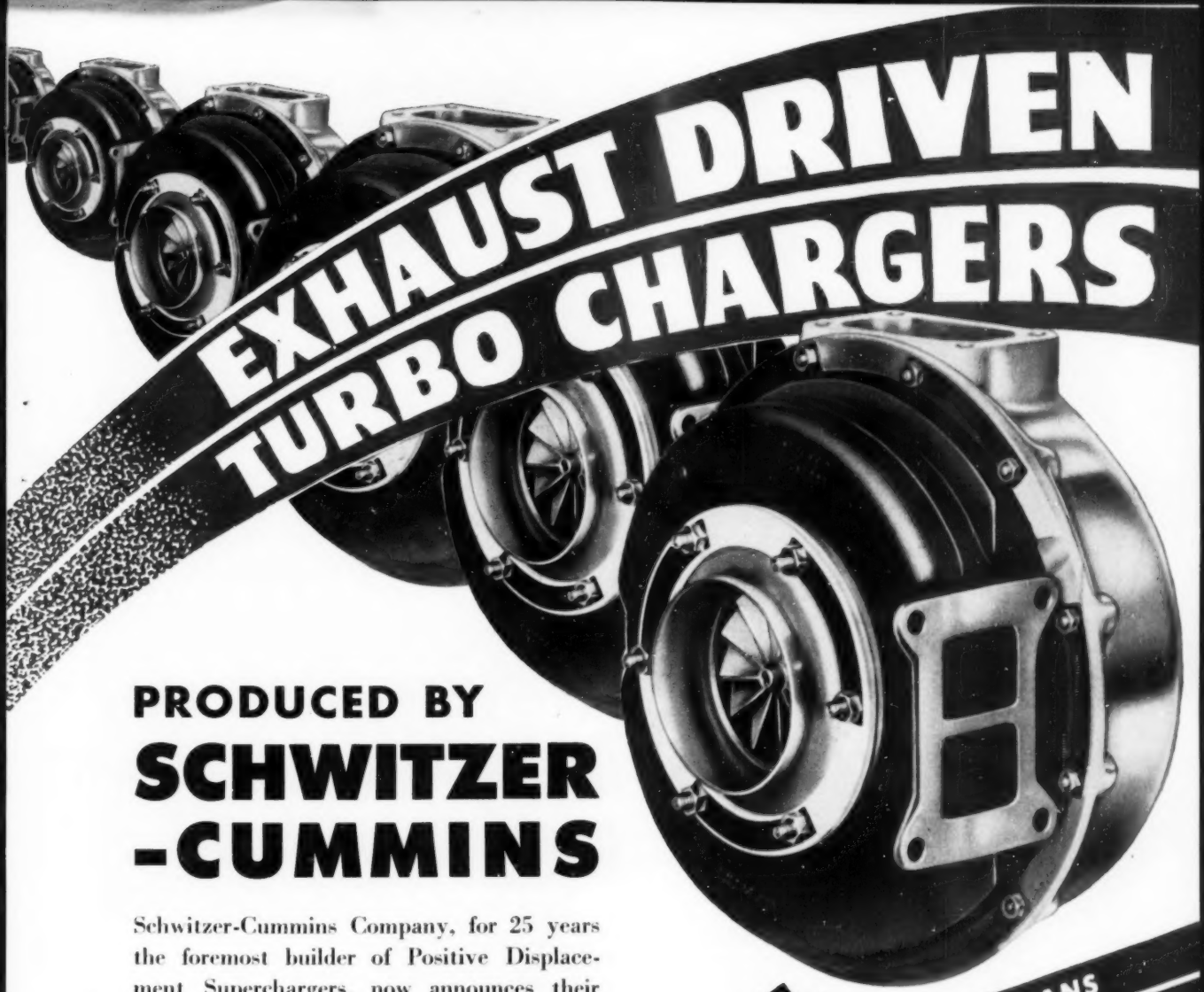
MATCHED UNITS BUILT BY ONE MANUFACTURER



Allison TORQMATIC DRIVES

COMPACT, EFFICIENT HYDRAULIC DRIVES FOR TRUCKS * CRANES * TRACTORS * SCRAPERS * SHOVELS * DRILLING RIGS

EXHAUST DRIVEN TURBO CHARGERS



PRODUCED BY SCHWITZER-CUMMINS

Schwitzer-Cummins Company, for 25 years the foremost builder of Positive Displacement Superchargers, now announces their latest engineering achievement, an Exhaust Driven Turbocharger with these outstanding features:

- First Lightweight, Low Cost Unit for Diesel Engines in the 100 to 200 Horsepower Range in the U. S. A.
- Simple, Reliable, Rugged Construction.
- Horizontal or Vertical Mounting, Simplifying Installation.
- Inertia of Rotating Parts Extremely Low, Assuring Immediate Response.
- Improved Fuel Economy Over Normally Aspirated Engine of Equivalent Output.
- Greatly Reduced Weight per Horsepower Ratio.

OTHER PRODUCTS

- COOLING FANS
- AIR STARTING MOTORS
- SUPERCHARGERS (POSITIVE DISPLACEMENT)
- OIL PUMPS
- WATER PUMPS
- CRANKSHAFT VIBRATION DAMPERS
- AUTOMATIC SHAFT SEALS
- PUMPS FOR AUTOMATIC TRANSMISSION AND POWER STEERING

SCHWITZER-CUMMINS COMPANY
1125 MASSACHUSETTS AVENUE
INDIANAPOLIS 7, INDIANA, U.S.A.

5300 miles a week for 50 weeks "Bearings good... shaft standard"

ONE of our delivery vehicles averages 5,300 miles a week. In a regular preventative maintenance inspection after fifty weeks we found the Monmouth* CLA Engine Bearings, both main and connecting rod, in good shape and the shaft standard. So reports the shop foreman of a large food distributor's delivery fleet in New England.

This is one more proof of the reliability and low service cost of Monmouth Bearings—made by the world's largest manufacturer of original equipment bearings. You can depend on their original equipment design, quality and accuracy. Use Monmouth Engine Bearings with confidence for replacement in passenger cars, trucks and buses.

Your NAPA Jobber is a Good Man to Know!

NAPA Assurance of Quality

*The words Monmouth, Clevite and Micro are registered trade marks of Clevite Corporation.

Monmouth ENGINE BEARINGS CLUTCH PLATES AND PARTS CHASSIS PARTS

Made by The Cleveland Graphite Bronze Co.— supplied through Clevite Service, Inc.
Units of Clevite Corporation, Cleveland, Ohio.

Even a thimbleful of fuel oil

burned in a General Motors Diesel locomotive, hauls one ton of freight one-half mile

A switch in time saves nine...

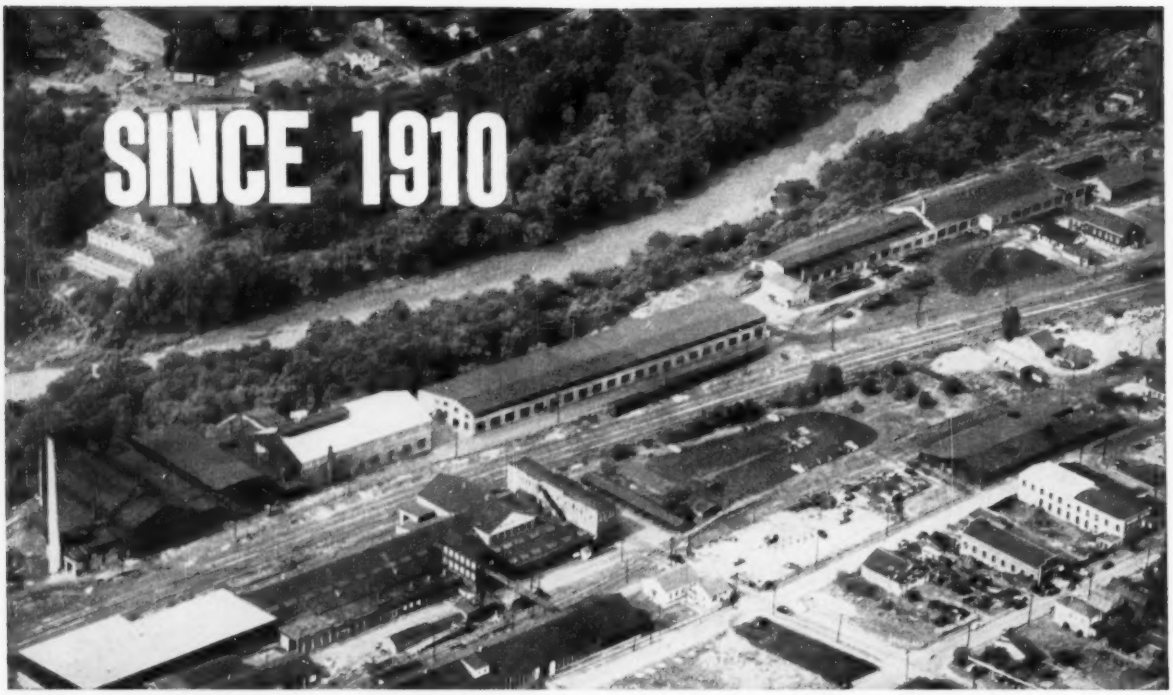
In yard-switching service, for example, a GM Diesel locomotive uses *nine-tenths less* fuel oil per hour than an oil-burning steam locomotive. If all work on railroads were done with Diesels, America would save 182,500,000 gallons of oil and 62,000,000 tons of coal a year.

TO CONSERVE FUEL AMERICA NEEDS MORE DIESELS!

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS

LA GRANGE, ILLINOIS—*In Canada:* GENERAL MOTORS DIESEL, LTD., LONDON, ONTARIO

If you are interested in the conservation of fuel by Diesel locomotives, write Electro-Motive Division for a recent study.



This aerial view of our plant will give you a good idea of our facilities for turning out crankshafts and forgings for diesels.

We have been at it since 1910, during which time we have been furnishing a constant and steady supply of crankshafts and forgings for use on diesel engines.

Manufacturers of diesels rely upon Ellwood City Forge for their most exacting requirements. We never disappoint them.

We suggest you write or look in on us for your crankshafts and forgings. We can take care of your needs in a thoroughly satisfactory manner.

Ellwood City Forge Company

ELLWOOD CITY PENNSYLVANIA

This consists of a GAS-GASOLINE or DIESEL ENGINE driven GENERATOR SET of the proper size to meet your needs and equipped with SYNCHRO-START controls to AUTOMATICALLY start the engine the instant the main source of power fails.

For the past twenty years we have been making the dependable controls that automatically start these stand-by power plants when power is required, and to stop them when power is no longer needed; also, to protect them from damage due to an abnormal condition while starting and running.

Synchro-Start Automatic Controls are constantly protecting lives and property all over the world — on the seas, in the air, on land and in the mines.

If you are not acquainted with the DEPENDABILITY and ECONOMY provided by SYNCHRO-START Controlled Power Plants, ask your engine manufacturer — engine dealer — engineering firm — architect or write us for our catalog and nearest representative. There is a stand-by power plant to meet every power need.

Automatic Engine Control Equipment

NATIONAL
TRADE-MARK
Traction Motor Brushes
COST LESS!

There are excellent reasons why *more* "National" Traction Motor Brushes have travelled *more miles* than all other makes combined and have shown lowest overall cost per mile of operation.

HERE'S WHY!

IN THE SHOP: Here's where such famous "National" grades as AZY and the new DE-3 *really pay off!*—by maintaining good commutator condition for longer periods. Since good commutator condition naturally affects *brush life*, "National" traction motor brushes *should* last longer—and they DO! Result: Lower maintenance cost . . . fewer brushes to buy and install.

ON THE ROAD: Operating cost boils down to two factors—*efficiency* and *dependability*. And again, "National" Traction Motor Brushes lead the field, operating with lower friction and carrying peak loads. Strong, low-friction brush grades, equipped with the "National" Permanently-Sealed shunt connection and fray resisting cable, provide unequalled dependability under the widest range of road conditions.

• Don't forget the big advantages of "National" *STANDARDIZED* Brushes—available for almost all types of road locomotives and for many switchers. Shipped from stock, they come to you in standard packages at the same low unit price!

START SAVING NOW WITH "NATIONAL" TRACTION MOTOR BRUSHES!

The term "National", the Three Pyramids device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of
Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IN CANADA: National Carbon Limited, Montreal, Toronto, Winnipeg

P&H Diesel Engines

(2-CYCLE)

Can you do this with your diesels?

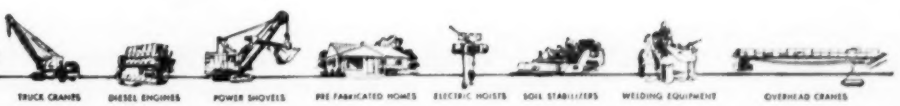
Within just 40 minutes you can remove a cylinder assembly — replace it with a complete new one — and have your P&H Diesel back in service.

No other diesel offers you such amazing speed and simplicity — such protection against costly lay-ups. Think what it can mean to you in time and cost savings — in simpler parts stocks. Where necessary, you can take an assembly from one engine to another . . . good reason in itself for standardizing on P&H Diesels.

This is only one of many advantages you'll find in this advanced line of P&H Diesels. Ask your nearest P&H Diesel representative for complete facts. Or write us.

P&H DIESEL DIVISION
HARNISCHFEGER CORPORATION
CRYSTAL LAKE, ILLINOIS

the P&H Line



Eaton Diesel Engine Valves, Bolts, and Studs

Produced to meet the exacting requirements of Diesel Engine Service

A background of many years of experience as suppliers to the Diesel engine industry gives Eaton a thorough understanding of the peculiar problems encountered in this highly specialized field. Eaton has made far-reaching engineering contributions applicable to practically all types and sizes of Diesel engines. Greatly enlarged manufacturing facilities permit the production of highly-stressed main-bearing and connecting rod bolts with forged heads, under strict metallurgical and quality control.

EATON MANUFACTURING COMPANY

CLEVELAND, OHIO

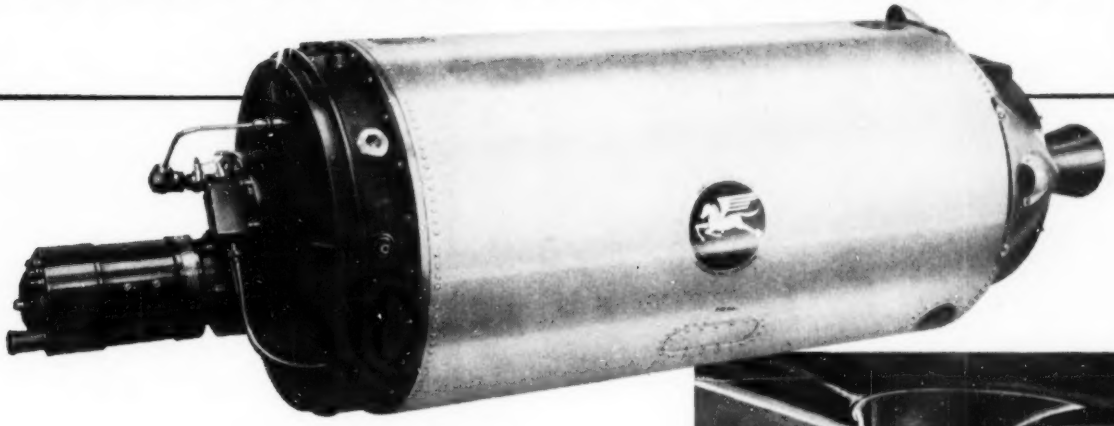
VALVE DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

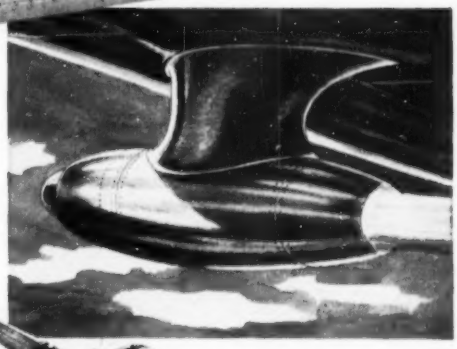
PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

NEW HIGH IN SPECIALIZED

POWER

3 LBS. THRUST FROM 1 LB. WEIGHT





The J-44 Monocoque Turbo-Jet Engine... Designed and Built by Fairchild

One of the most compact engines in its power class ever produced is the Fairchild J-44 Monocoque Turbo-Jet. Only 72 inches in length, 22 inches in diameter and weighing only 300 pounds, the J-44 delivers a thrust of 1000 pounds.

Another example of a Fairchild design which met difficult and exacting specifications, the J-44 typifies the creative engineering ability of the Fairchild Engine Division.

Right now, the Fairchild J-44 Monocoque Turbo-Jet is being produced exclusively for the Armed Services. When conditions permit, this mighty midget will become available to boost payloads and lower operating costs of airline transports and other aircraft.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Engine Division
FARMINGDALE, N. Y.

Aircraft Division
Hagerstown, Md.

Guided Missiles Division
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More and more POWER developments for America's Armed Forces

MEETING TODAY'S POWER NEEDS WITH dependable engine cooling

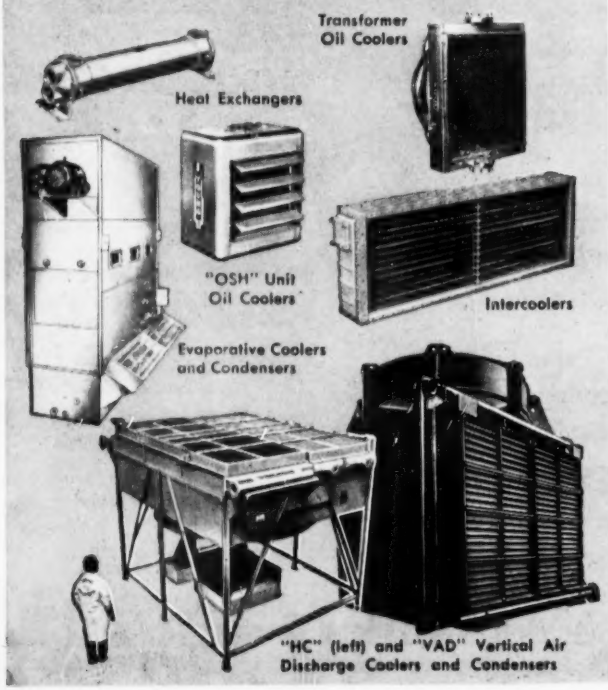
YOUNG ROUND TUBE CORE RADIATOR

for lube oil and jacket water cooling

The Sterling Engine Company, Buffalo, N. Y., selects Young "Mono-Weld" Radiators with round tube cores for dependable an economical cooling of lube oil and jacket water for a number of Diesel-generator units built for the Corps of Engineers, U. S. Army. These Young Radiators dissipate 2,250,000 Btu's per hr. for each of the 500-kw semi-portable Diesel generator sets.

As illustrated, many Young Heat Transfer products are serving in stationary, portable and stand-by power plants, in oil-field pipeline compressor and booster stations, etc. One-piece or sectional-type core Radiators are available in various sizes, dissipating from 70,000 to 3,250,000 Btu's per hr. For details, see your Young Distributor or write direct.

OTHER YOUNG ENGINEERED PRODUCTS FOR POWER GENERATING PLANTS


Transformer Oil Coolers
Heat Exchangers
"OSH" Unit Oil Coolers
Intercoolers
Evaporative Coolers and Condensers
"HC" (left) and "VAD" Vertical Air Discharge Coolers and Condensers

YOUNG

Heat Transfer Products for Automotive and Industrial Applications.

Young Quality

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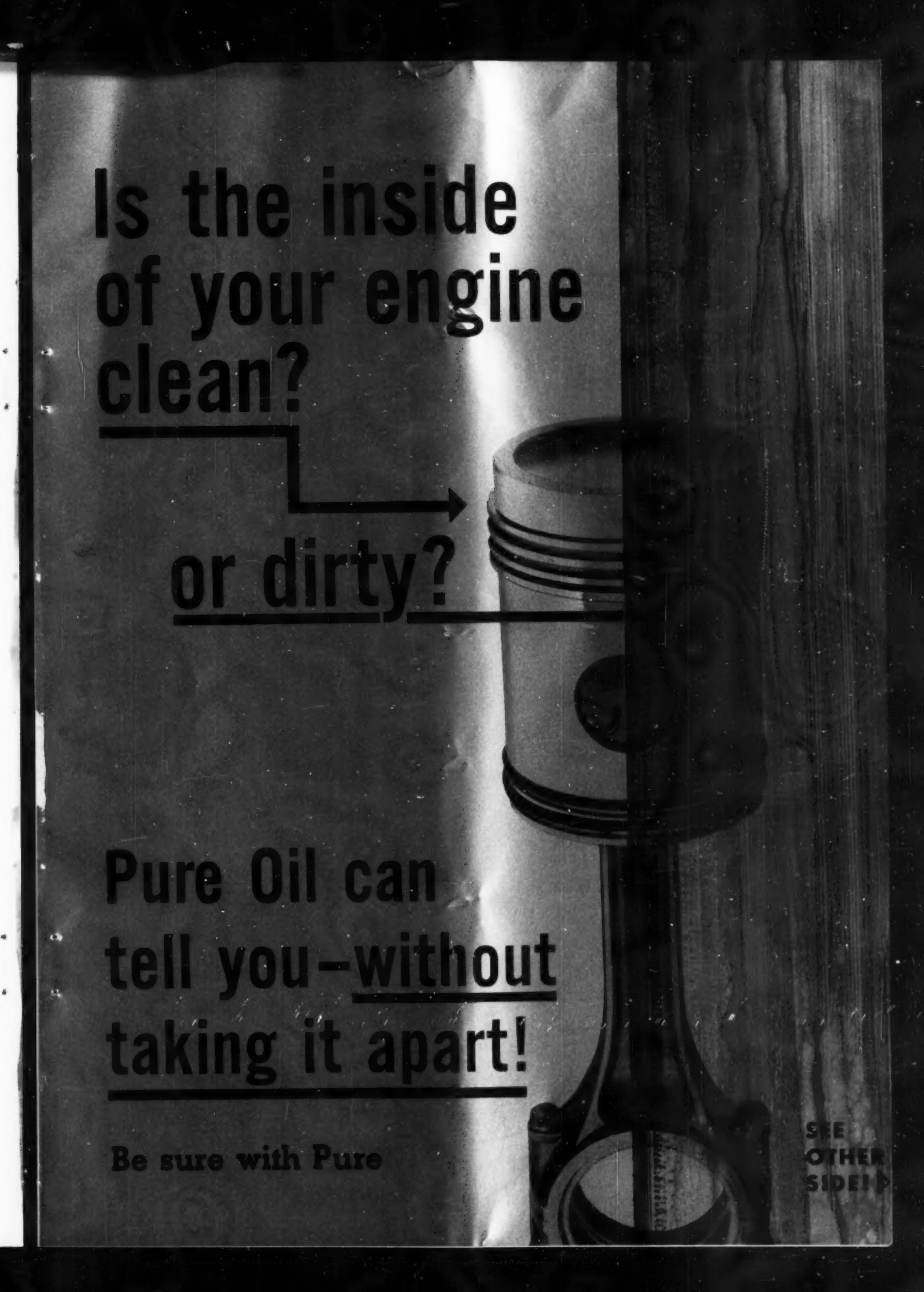
Heating, Cooling, Air Conditioning Products for Home and Industry.

YOUNG RADIATOR COMPANY

Dept. 413-D RACINE, WISCONSIN

Factories at Racine, Wisconsin and Mattoon, Illinois
Sales and Engineering Representatives in All Principal Cities

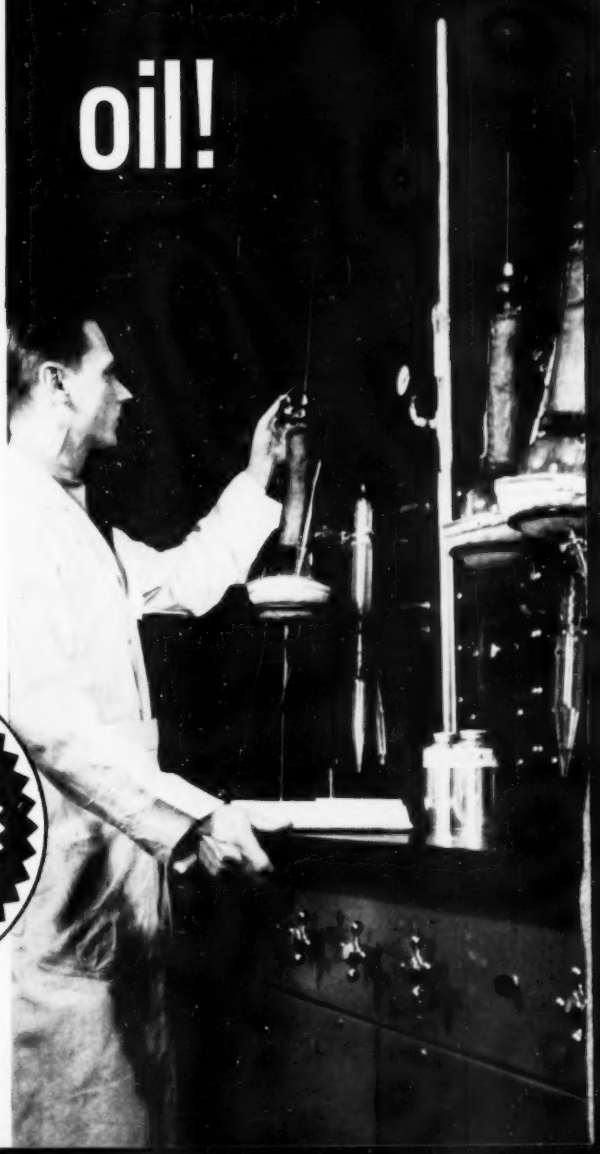

Is the inside of your engine clean?
or dirty?
Pure Oil can tell you—without taking it apart!
Be sure with Pure
SEE OTHER SIDE!

(Continued from other side)

Is the inside of your engine clean? Or dirty?
Is your engine using too much oil or fuel? Why?
Should you change oil more frequently?
Or less frequently?
Is your oil filter working effectively?
Are you going to have trouble with rings?
Or pistons? Or bearings?

We'll give you the answers free!

Give us a pint of your used oil!



How? By means of a free Pure-sure Analysis made in our multi-million dollar research laboratories (a scientific check of oil contaminants such as tarry materials, fuel, water, dirt, and metal particles).

Why? To introduce you to—to give you a taste of—the kind of service available to Pure Oil customers. There is no obligation. Address your request to your local Pure Oil office* or to Dept. D-34, The Pure Oil Company, 35 East Wacker Drive, Chicago 1, Illinois.

This offer must be limited to areas where Pure Oil products are sold.

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Columbus • Indianapolis • Jacksonville • Madison • Memphis • Miami
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3051

Men who depend on power...know they can depend on CUMMINS®

CUMMINS DIESELS **are engineered to make light work of tough jobs**

D-126

In all fields where power is used, owners agree that Cummins Diesels get more work done at lower cost . . . with minimum maintenance needs.

Steady on-the-job dependability is built into every Cummins Diesel. Every engine gets special care. In engineering, research and production, no detail is overlooked. As a result, Cummins owners can rightly say that there is far less "down time" with a Cummins Diesel.

What's more, lightweight, high-speed (60-600 h.p.) Cummins Diesels save on fuel costs, too. Thanks to Cummins' exclusive fuel system, you get more performance per gallon on the job. See your Cummins dealer soon. He's a Diesel power specialist — ready to show you how a Cummins Diesel can serve in your operations.

CUMMINS

***Leaders** in rugged, lightweight high-speed diesel power!*

CUMMINS ENGINE COMPANY, INC., Columbus, Ind. *Export:* Cummins Diesel Export Corp., Columbus, Ind., U.S.A. • Cable: CUMDIEX

For proven dependability...

AUTO-LITE

diesel equipment

For over 42 years Auto-Lite has been building complete electrical systems for the makers of many of America's finest cars, trucks and tractors. It is this experience that makes possible the outstanding dependability achieved in Auto-Lite Diesel Equipment—from generators to voltage controls—from batteries to starters. This unfailing reliability in service has helped to make Auto-Lite the world's largest independent manufacturer of automotive electrical equipment. If you have a particular diesel problem, Auto-Lite invites you to write to

THE ELECTRIC AUTO-LITE COMPANY
Toledo 1, Ohio — Sarnia, Ontario

STARTERS
BATTERIES
GENERATORS

Tune in "SUSPENSE!" . . .
CBS Radio Mondays . . . CBS Television Tuesdays

Another TOCCO® First!

INDUCTION HARDENED CYLINDER BORES...

for much longer engine wear— at much lower cost

PROBLEM:

Cylinder liners cost a lot of money, and, of course, they take up space that could be used for generating extra horsepower.

As a result engine builders, hoping to abolish the need for liners, experimented with various hard alloy irons that can furnish desired hardness in the cylinder bores.

However, these hard castings were extremely difficult to machine, and they cost several dollars per casting extra.

SOLUTION:

Now TOCCO® has developed and patented a process for Induction-hardening the cylinder bores of conventional, cylinder-iron castings. The blocks are easy to machine, yet cylinder bores are very hard to a depth of about 1/16". This depth of hardness permits several re-honings with no loss of hardness in the cylinder bore.

The cost?—less than half the extra cost of alloy iron cylinder blocks.

This important development is typical of the way TOCCO works hand-in-glove with the Metal Working Industry to improve products and lower costs.

see our catalog in MACHINE TOOL CATALOGS or write for copy

THE OHIO CRANKSHAFT COMPANY

TOCCO

NEW FREE BULLETIN

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Please send copy of "Typical Results of TOCCO Induction Hardening and Heat Treating"

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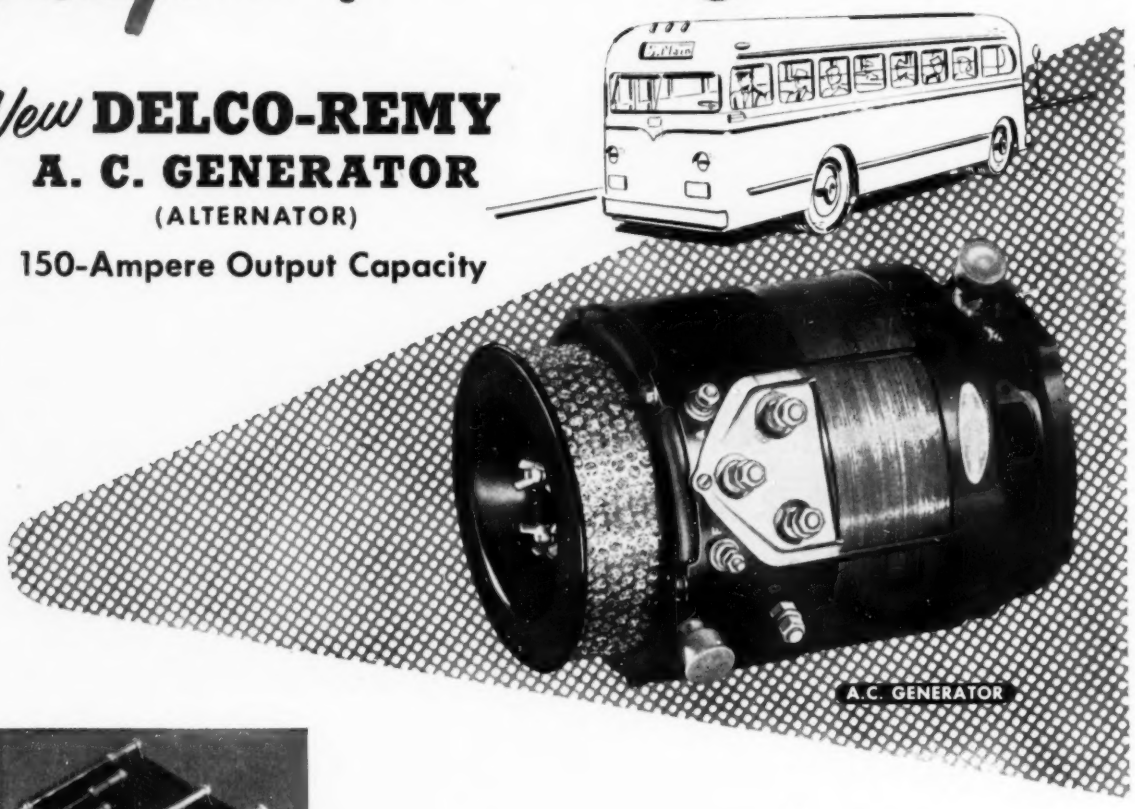
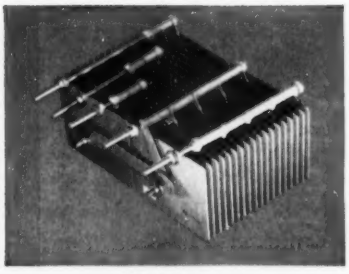
Right for the Job!

New DELCO-REMY
A. C. GENERATOR
(ALTERNATOR)

150-Ampere Output Capacity





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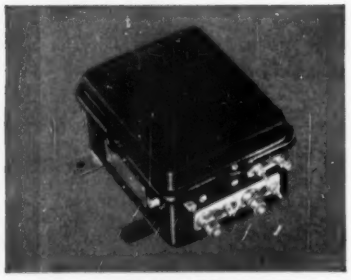


REGULATOR

The new Delco-Remy A.C. generator is the heart of a 12-volt A.C.-D.C. electrical system designed specifically for modern Diesel buses with fluorescent lighting and extra-heavy electrical loads.

It cuts in at approximately 550 generator rpm and reaches a maximum output of 150 amperes at approximately 1175 rpm.

The new generator not only supplies alternating current for fluorescent lighting, but also ample direct current for the heaviest electrical loads coupled with lengthy engine-at-idle periods.

Impressive features of the new generator are its relatively light weight, its very high output capacity and its ability to operate over a wide range of speeds.

Specify Delco-Remy electrical equipment on your new buses.

DELCO-REMY

Division, General Motors Corporation, Anderson, Indiana

WHEREVER WHEELS TURN OR PROPELLERS SPIN

Parts within Hours
—from Factory to You

Check these points on Enterprise Diesel Service

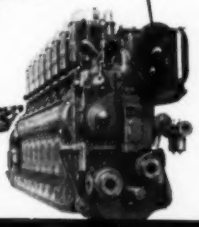
12 service offices, strategically located parts warehouses — for fast round-the-world service.

Prompt processing and factory delivery on parts not normally stocked in local warehouses.

Quick handling of all routine or emergency overhaul work.

Expert supervision of any engine service constantly available by experienced ENTERPRISE Service Engineers.

ADD IT ALL UP and it pays to buy ENTERPRISE — backed by ENTERPRISE Specialized Service.



Take the case of this "hurry-up" call from Venezuela, for example—

On January 9th at 10:30 A. M. this cable was handed to M. T. Prendergast, ENTERPRISE Manager of Service Parts in San Francisco:

"URGENT AIR EXPRESS TWO FUEL TAPPET AND GUIDE ASSEMBLIES NO. 78153"

It came from T. P. Jiminez, Manager, Fuerza Luz Tuy — power company in Ocumare Del Tuy, Venezuela. Prompt handling saw this rush order airborne by early afternoon, and *delivered to the customer 44 hours and 15 minutes later!*

This is typical of the service you can expect from ENTERPRISE. We know what delivery delays can mean — how costly it can be when engines are idle for need of a part. That's why ENTERPRISE Parts Service is geared to the *customer's* requirements, and why we insist that furnishing prompt and efficient service is every bit as important as building the very finest Diesel engine.

Write for new descriptive bulletins, or call your nearest Enterprise Diesel Sales Office.

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DEPENDABLE
Diesels

ENTERPRISE ENGINE & MACHINERY CO.
18th & Florida Streets, San Francisco 10, California
A SUBSIDIARY OF GENERAL METALS CORPORATION

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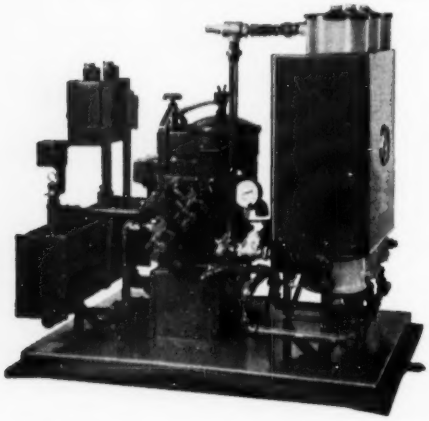
DIESEL ENGINES • OIL BURNERS • PROCESS MACHINERY

THE DE LAVAL "PURI-FILTER"



Note these Features

- Removes dirt and water by centrifugal force
- Filters out harmful carbon
- Does not remove valuable additives
- Cleans oil at moderate temperature
- Speeds up inspection—crankcase is cleaner
- Minimizes ring sticking
- Increases bearing life
- Saves labor—long runs without bowl cleaning
- [redacted]
- No dirt . . . carbon . . . or water

Because it provides the best means ever devised for keeping diesel oil clean, the De Laval "Puri-Filter" extends the useful life of the oil indefinitely. Centrifugal force, applied within the bowl of a De Laval "Uni-Matic" Oil Purifier first frees the oil of most solid impurities and all water. Then the oil passes through a Fram "Filcron" Filter, which removes colloidal carbon and other minute contaminants.

The De Laval "Puri-Filter" leaves the oil a clear translucent amber color. It is ***visibly*** clean, and thus provides the utmost in protection for every diesel engine.

Used to purify fuel oil, a De Laval centrifuge makes it possible to burn cheaper grades of residual fuel with perfect safety and an appreciable saving of money.

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

[redacted] *Oil Purifiers*

[redacted] RICATING OIL

NINETEEN MAXIM SILENCERS ON THIS RAM JET STAND

UNITED AIRCRAFT in East Hartford runs this laboratory for ram jet testing so quietly that its operation can scarcely be heard at a distance of 100 yards. Maxim Silencers, ***19 in all,*** effectively silence exhaust and intake of engines, compressors, and ram jet exhaust. For the solution to unusual silencing problems, consult Maxim, the company unequalled in silencing experience.

Consult

MAXIM

THE MAXIM SILENCER COMPANY
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Gentlemen:
Please send me your bulletins on Exhaust and Intake Silencers.

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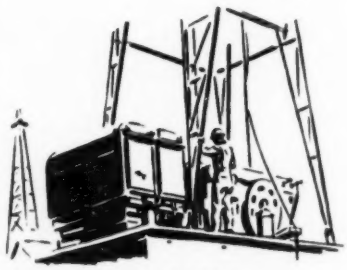
Designed to the Special Demands of Industry

HERCULES DIESELS

AUTOMOTIVE

AGRICULTURE



OIL FIELD

CONSTRUCTION

No matter how tough the task . . . you'll find a lightweight, high-speed, heavy-duty HERCULES diesel engine available to do the job, and do it well!

And, when it comes to continuous on-the-job performance . . . low operating cost . . . maximum fuel economy . . . and minimum maintenance . . . you'll agree that HERCULES diesels are a profit-wise choice for dependable power.

For your future diesel power requirements take advantage of the special service Hercules provides industry. That is, a diesel to meet your specifications. No matter what industry—transportation, marine, agriculture, construction—Hercules diesels are designed to the special demands of industry. It will pay you well to discuss diesel power with a Hercules engineer.

HERCULES DIESEL ENGINES

Model	Bore & Stroke	Displ.
2 CYLINDER		
DIX2D-B3	3⅝" x 4"	83
DIXC	4" x 4½"	113.1
DIXD	4¼" x 4½"	127.5
4 CYLINDER		
DIX4B	3¼" x 4"	133
DIX4D	3⅜" x 4"	166
DOOB	3⅜" x 4½"	198.8
DOOC	4" x 4½"	226.2
DOOD	4¼" x 4½"	255
6 CYLINDER		
DIX6D	3⅜" x 4"	249
DIX6-272	3-11/16" x 4¼"	272
DJXB	3½" x 4½"	260
DJXC	3¾" x 4½"	298
DJXH	3¾" x 4½"	298
DJXHF	3¾" x 4½"	298
DWXC	4" x 4¾"	358
DWXD	4¼" x 4¾"	404
DWXLD	4¼" x 5"	426
DWXLDF	4¼" x 5"	426
DRXB	4⅜" x 5¼"	474
DRX-501	4½" x 5¼"	501
DRXC	4⅝" x 5¼"	529
DFXB	5" x 6"	707
DFXC	5¼" x 6"	779
DFXD	5½" x 6"	855
DFXE	5⅝" x 6"	895
DFXH	5¾" x 6"	935
DFXHF	5¾" x 6"	935
8 CYLINDER		
DNX-VBC	6" x 6"	1348
DNX-VBDTS	6¼" x 6"	1468

Engine Manufacturing Specialists Since 1915

HERCULES MOTORS CORPORATION • Canton 2, Ohio, U.S.A.

Wear Control

VAN DER HORST
TRADE MARK

* *PORUS-KROME is a dense, hard, wear and corrosion-resistant chromium, produced by the Van der Horst Corporation of America, and which gives working surfaces an infinite number of tiny oil-retaining reservoirs for perfected lubrication.*

U. S. PATENTS
2,048,578, 2,314,604 and 2,412,698

Here's a proven way to bracket your Diesel cylinder wear costs and clamp them down to a minimum. The same can be done for compressors.

Just send your worn liners and cylinders to Van der Horst. If they've already been oversized to the limit, that doesn't matter. We can plate them all back to original bore dimensions with VANDERLOY M.

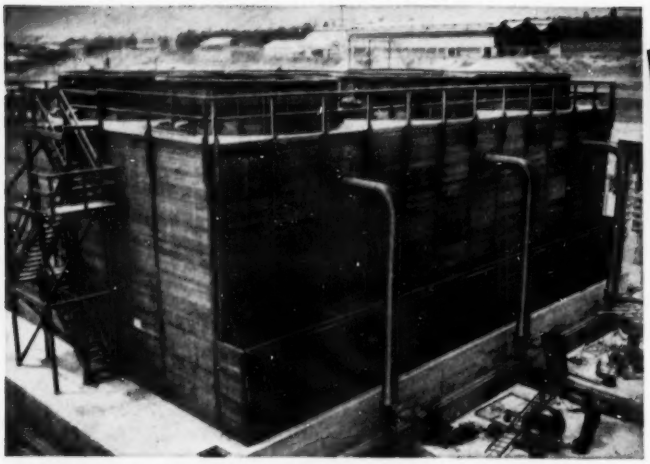
This pure electrolytic iron bonds atomically and can be developed a quarter of an inch thick, if that's essential.

Over the VANDERLOY M we plate PORUS-KROME*. It makes cylinders last as much as four times longer than they did when new and unprocessed.

Then, back they go, ready to give you efficient and dependable service, until at long last they need another Van der Horst processing.

Since the cost for all this is surprisingly less than the price for new, unprocessed replacements, we think you'll want to know more about our wear control method. Why not drop us a line? W52-19

VAN DER HORST CORPORATION • OLEAN, N. Y.



EXACTING SPECIFICATIONS WERE MET by Pritchard design engineers in this Mexico City installation. Jacket water from six heavy-duty Diesels gets a cool-down from 110° to 90° F. at the rate of 12,960 GPM and at more than 7,000 feet above sea level!

Thoroughly Engineered... Adequately Sized for Efficient Cooling of Diesel Engine Jacket Water and Lubricating Oil

PRITCHARD QUALITY COOLING TOWERS

QUINTAIR®
Air Cooled Heat Exchangers

WATER CONSERVATION AT WORK

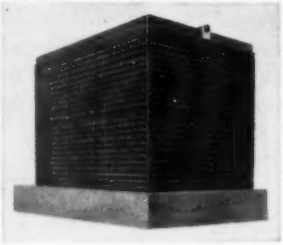
Whenever you see a Pritchard Cooling Tower or QUINTAIR* you see water conservation at work. In dissipating heat to the atmosphere, Pritchard equipment assures you greater efficiency and economy—*plus water savings up to 99% over former wasteful methods.*

GUARANTEED delivery of rated performance with *emergency* output to spare... long years of service with operating economy... these are the things you can *rely* on when you buy or specify a Pritchard Quality Cooling Tower or a Pritchard Quintair* Air Cooled Heat Exchanger.

The high industry acceptance of Pritchard cooling equipment for Diesel engine jacket water and lubricating oil has been built up through our more than 25 years experience in this field.

We offer a full line of equipment in a wide range of types and sizes, one of which is exactly right for your specific requirements. Each is *thoroughly engineered* and *adequately sized* to give top performance under the most exacting conditions. Your inquiry invited. Quotations promptly furnished.

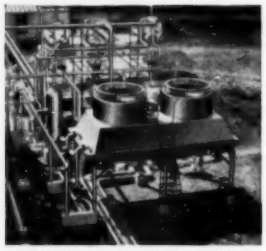
COTOSPRAY® Cooling Towers



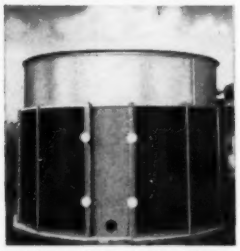
COTOSPRAY* SR12 Tower is used in jacket water cooling service. Foundation is furnished by customer.

Thermal capacity of Pritchard COTOSPRAY* Towers is guaranteed for the life of the towers. They're rugged, dependable, and require a minimum of maintenance. They offer you the lowest cost per unit of cooling . . . easier assembly with no special skills or erection tools required . . . a wide range of capacities. Only select All Heart Redwood is used. Complete, packaged units, 3 to 221 tons capacity.

QUINTAIR® Air Cooled Heat Exchangers



PRITCHARD TYPE "B" QUINTAIR* Heat Exchangers are designed and built for long and trouble-free service. Design assures more even distribution of air over heat transfer sections.



PRITCHARD TYPE "E" QUINTAIR* unit has curved heat transfer sections which increase fluid turbulence, resulting in greater heat transfer rates for any given pressure drop.

PRITCHARD QUINTAIR* Air Cooled Heat Exchangers efficiently handle the cooling load where water is unavailable, expensive, or presents other difficulties. A single unit can handle several different heat loads simultaneously.

*Registered Trade Names

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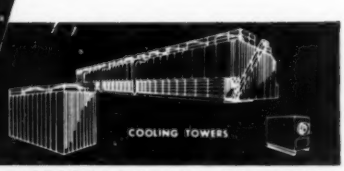
J.F. Pritchard & Co.

EQUIPMENT DIVISION

Dept. 300, 210 West 10th Street, Kansas City, Mo.



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American Society of Lubrication Engineers
Hotel Statler, Boston, Mass.
April 13-15

...with TYCOL lubricants on hand!

Take heavy mechanical equipment, for instance. There's a Tycol lubricant for any application you name: For instance, what about steam turbines? . . . Tycol Aturbrio oils resist heat and sludging, are "double inhibited" to provide the utmost resistance to rust and oxidation. Diesels? . . . Tycol Adelbus oils contain additives that produce a tough "film of protection" and help to eliminate sludge and varnish. You always get top performance with Tycol lubricants. Why? . . . Because each Tycol grease and oil is manufactured from high quality base stocks and *tailored* for a specific application. Get the full story of the entire Tycol line from your local Tide Water Associated office today!

Over 300 Tycol industrial lubricants are at your disposal . . . engineered to fit the job!

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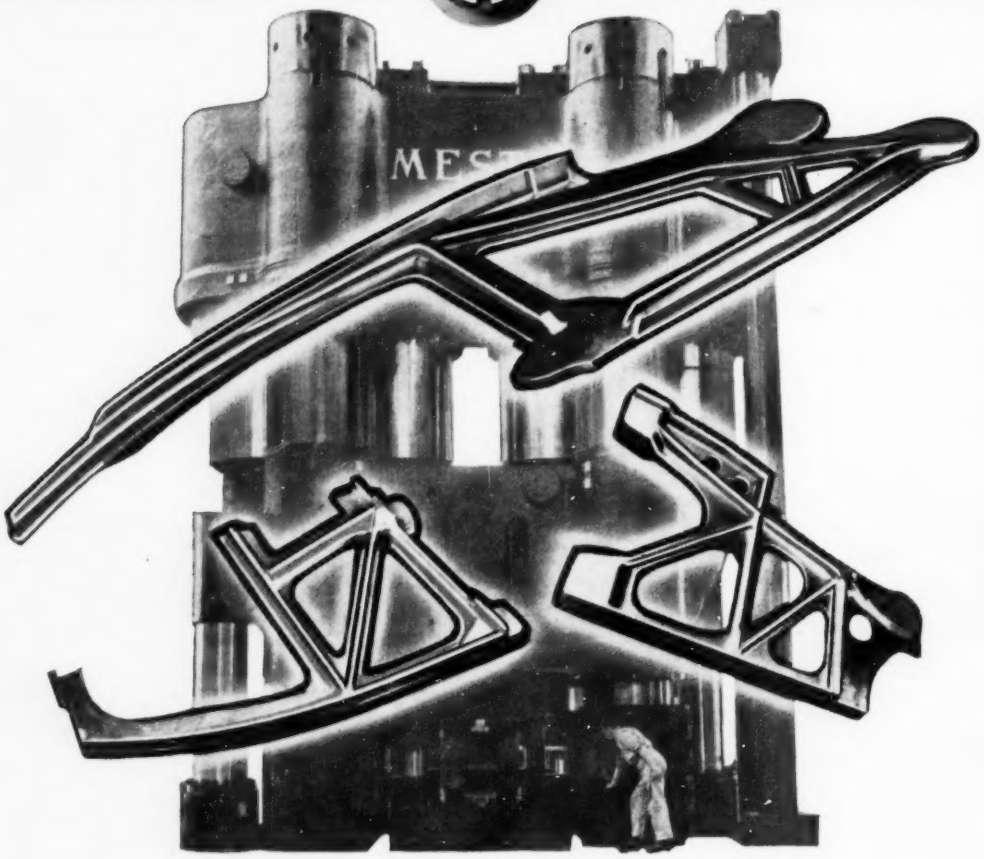

Greater Size and Speed in Aircraft have created engineering problems, the solution of which has required larger and larger forgings of high-strength aluminum alloy. *Examples* shown above are forged structural members used in a modern military bomber, the largest more than seven feet over all. These are forged on an 18,000-ton press, the biggest ever built in this country.

Wyman-Gordon Experience—the most extensive in the industry—is keeping abreast of new forging demands involving the use of Steel, Aluminum, Magnesium, High Density Alloys and Titanium.

• • •

Standard of the Industry for More than Sixty-five Years

WYMAN-GORDON

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN

PETTER

DIESEL ENGINES

AIR-COOLED · WATER-COOLED

From

3 H.P. TO 40 H.P.

LOW COST

POWER UNITS FOR

- *MARINE AUXILIARIES*
- *GENERATORS*
- *PUMPING EQUIPMENT*
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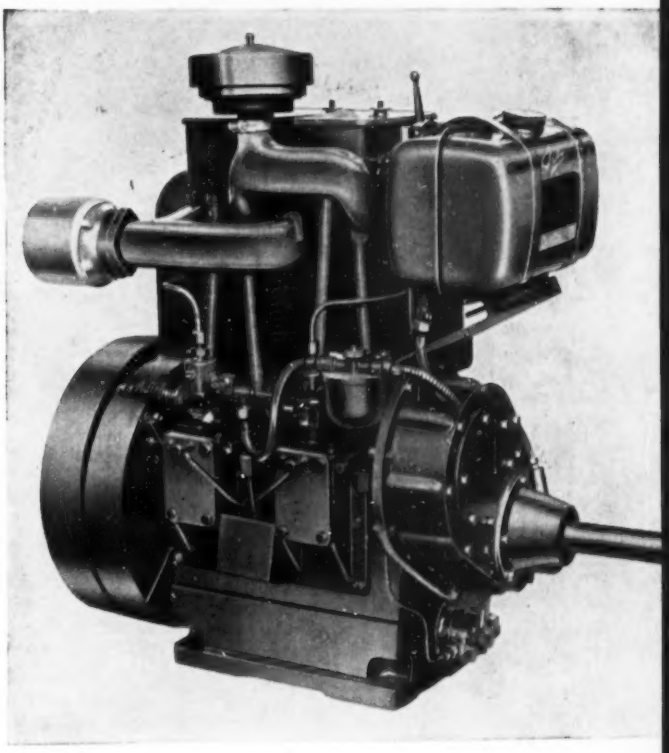

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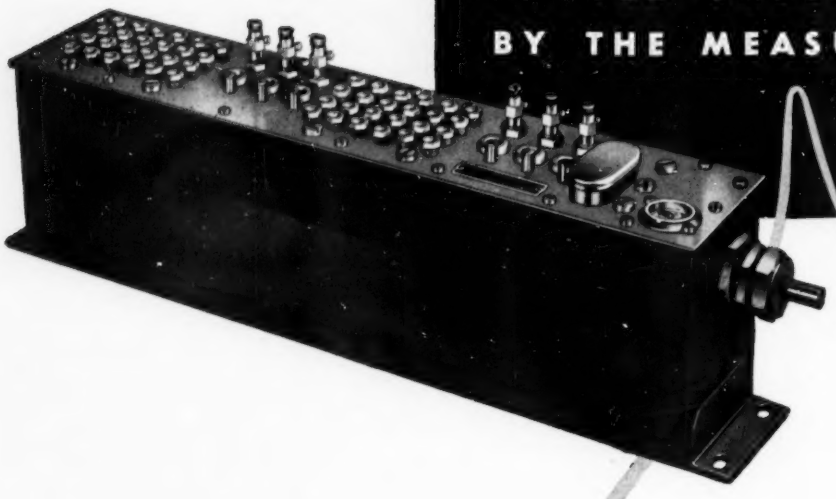

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April, 1953

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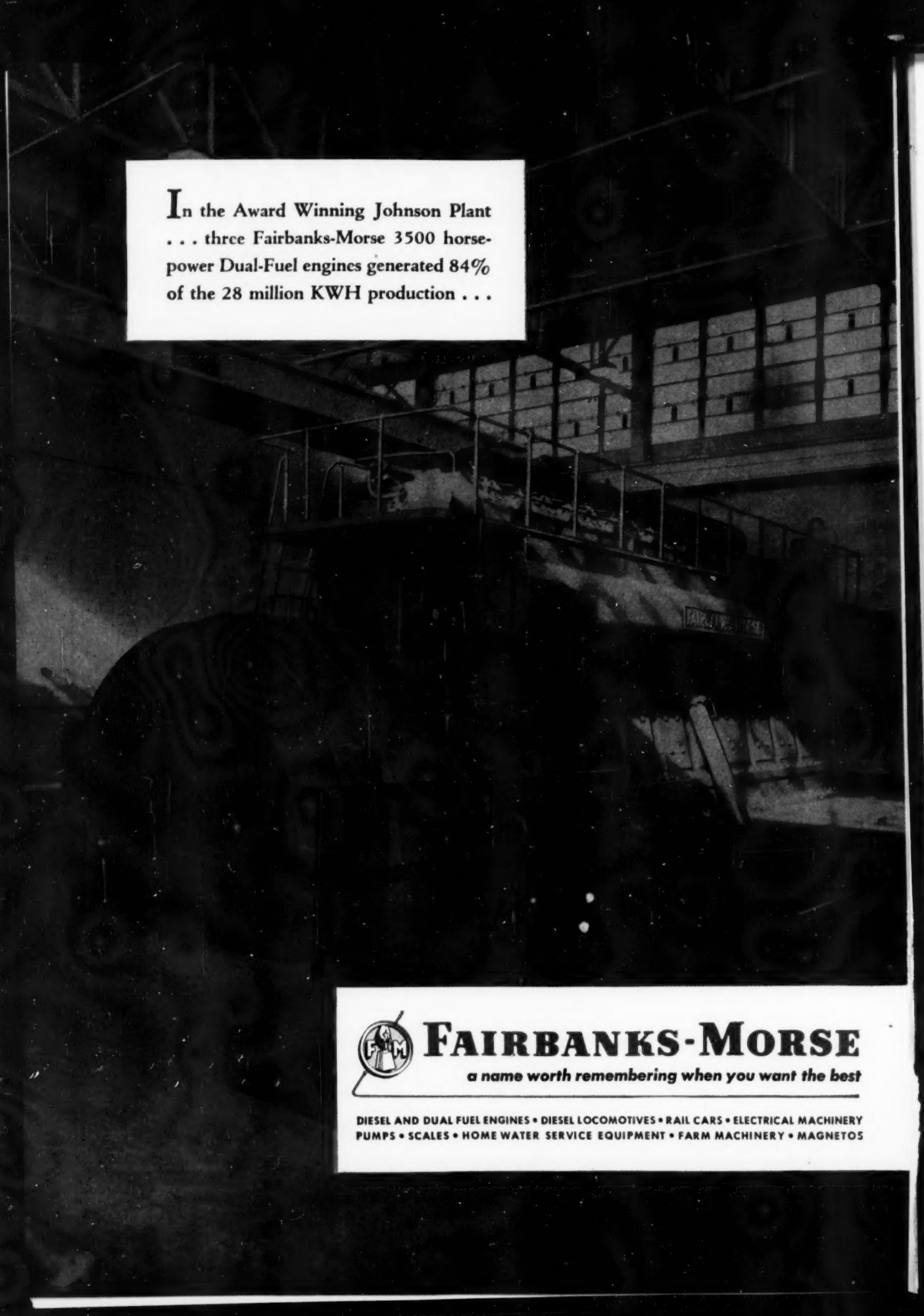

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Editorially Speaking . . . .

Don't Be Smug

EVERY so often we get something in the mail that punches over a point and starts us thinking. We are indebted to A. L. Torgis and Son, Ltd., of Toronto, Canada, for this month's "self-starter." Mr. Torgis is a parts jobber and does some mighty good engine rebuilding.

Listen to what he has to say in a "Half-Century of Progress" service bulletin of recent date:

> "Every time a jobber sees advertising of 'Genuine Parts' by an original equipment manufacturer, he has reason to be proud for his contribution.
>
> "Early cars and trucks did not have bumpers, electric lights, batteries, windshield wipers, filters, aluminum and lightweight cast iron pistons, gauges, speedometers, chrome piston rings, free or rotating type valves, or many items too numerous to mention. Most of these were invented, nationally advertised, and distributed through the parts jobber and engine rebuilders.
>
> "Public demand caused them to be adopted as original equipment for future production. They were then given the name 'Genuine Parts and Accessories'."

While Mr. Torgis' comments apply most directly to the automotive field, stop and think a minute. How many similar cases can you think of in the diesel field? We can think of several. Suppose that we just pinpoint one.

An engine salesman told us the case history of a high-speed unit that he had sold for hard, continuous service. It delivered its power, the fuel economy was good, and in general the rig was doing an excellent job. There was one trouble. At regular and fairly frequent intervals, the aluminum pistons had to be replaced due to excessive ring groove wear.

Although representing the manufacturer, he quietly went out and bought a set of aluminum pistons having bonded Ni-Resist ring carriers from an independent piston manufacturer. These were installed without fanfare and the engine went about its job with the old trouble eliminated.

The customer was so pleased that he bought another similar engine. Shortly however, the cry went out to the salesman (who had left the company in the meantime), "Whatever you did to the old engine, come back and do it to this new one."

Now the company had been experimenting with pistons of this type for some time, but were checking, double-checking, and then rechecking them. The question arises, "When does a commendable conservatism to protect the reputation of the product stop, and smugness start?" Incidently, the company now uses this type of piston to a great extent.

It is very easy to fall into smug ways. The vast majority of the ideas offered to "improve the product" must be approached warily and it soon becomes easiest to rely solely on ideas generated in the engineering department. It takes time and trouble to separate the sheep from the goats, but it can be well worth it.

Progressive engineering is not only design and development but evaluation as well. Evaluation should also consider the sales angle; it may not be outstanding engineering-wise, but it may be darn good for business. A smart engineer-executive once told us, "We may be forced to build that feature into our engines. We don't believe in it; we don't think it's necessary or even good engineering, but the people want it and we are in business to sell engines."

So let's not be smug; let's keep our eyes open to the things going on around us. Capitalize on the outside brain power that is being expended frequently on a single engine component. Let's have all practical developments of today in today's engines.

Sign of good lubrication for Diesel locomotives *

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+ HIGHLIGHTS +

● Cincinnati, Ohio will be host to the Automotive Engine Rebuilders Association for the fourth time, when the AERA holds its annual convention on the 4th, 5th and 6th of May.

● From May 14 to 23, Tulsa, Oklahoma will be the scene of the International Petroleum Exposition.

● According to the National Foremans Institute, the Wisconsin CIO ran a bowling tournament with an entry fee of a pint of blood for our service men in Korea.

● Back in 1866, the first sleeping car was constructed by George M. Pullman at a cost of $20,000. Today, the cost of a Pullman sleeping car is in the neighborhood of $153,000.

● Sixty per cent of America's motor vehicle traffic is concentrated on seven per cent of the road mileage. Yet two-thirds of the nation's main highways are regarded as short of safe driving standards.

● In a recent forecast. the U. S. Bureau of Mines said that demands for gasoline and distillate fuels would rise during 1953 by 5.5 per cent for gasoline and 7.7 for distillate fuels.

● GM recently stated that freight hauled by GM diesel locomotives moves at an average speed. for the nation, 50 per cent faster than that of the average speed of freight still moved by steam locomotives.

● During the last seven years, over 11,000 diesel-electric locomotives have been placed in service on Class I railroads in the United States.

● "Man bites dog"—From Johnson and Higgins, insurance brokers, we hear a jury recently awarded $99,233 to a railroad for damages to one of its diesel locomotives caused by a grade crossing collision with a truck. Flames from the truck spread to the train causing damage for which the trucking firm was held liable.

● As of March 1, 1953, the backlog of freight cars on order was 71,883. Of this amount 2284 cars were on orders placed in February.

● A milestone in industrial safety has been achieved according to GE. The end of 1952 marked a half-decade of accident-free operation at their Anaheim, California plant. How is your accident record?

● Proved natural gas reserves rose to 199.7 trillion cu ft at the end of 1952 which is an increase of 5.9 trillion cu ft over the record high of the preceding year.

● Mr. Earl Bartholomew, of the Ethyl Corporation Research Laboratories recently told the API that over 800 million lb of chemicals are now added annually to automotive petroleum products to enable them to meet the requirements of modern engines.

● Average performance per freight train hr has increased from 7506 ton-mi in 1921 to an estimated 22,521 ton-mi in the first 10 mo. of 1952, according to the AAR. This is a gain of 200 per cent.

● The trucking industries Customer Relations Council will hold their annual convention from April 19 to 22 at the Belleview Biltmore Hotel, located in Belleair, Florida.

● Central Research Laboratories of AAR's Technology Center at Chicago, Ill., are erecting a new mechanical research building to house their expanded mechanical research program. The program will include investigations on causes of freight car journal box failures.

● Natural gas and oil production smashed all records in 1952 according to API. Liquid petroleum output amounted to 2.5 billion bbl, an increase of 60 million bbl over 1951 and natural gas 8.6 trillion cu ft, an increase of 672 billion cu ft over the 1951 mark.

● Proved reserves of liquid petroleum went up to 32.9 billion bbl as of last December 31—an increase of more than 764 million bbl over 1951's former peak.

● Annual Convention of the American Gas Association will be held from October 26 to 28 in St. Louis, Mo.

● GMC now has two base training schools for diesel truck mechanics at Detroit, Mich. and Oakland, Calif., plus four mobile schools traveling throughout the country.

● Availability of cheap dependable hydro power has recently been boosted in the Pacific Northwest. This has been brought about with the help of warm weather and heavy rains which have, for the time being, ended power shortages in that area.

● A recent meeting of the American Railway Engineering Association saw the election of C. G. Grove, Chief Engineer of the Pennsy's western region, to President of the association.

● "Industry Moves South" will be the theme of the Southern District Meeting of the AIEE in the Hotel Seelbach, Louisville, Ky., April 22 to 24.

● EMD is currently training several students from Pakistan and Brazil, in the maintenance and operation of EMD diesel locomotives. Railways in both countries will soon receive GM locomotives now on order.

● There is a freight car in the United States for every 76 persons in the country.

● A new chemical (not electrolytical) plating process was recently announced at a luncheon held at the Plaza Hotel in New York City by the General American Transportation Corporation. The new process has been developed to deposit an absolutely uniform coating of nickel on almost any material regardless of size or shape.

Two Years With Bunker "C" Fuel

By Robert J. Dodd Chief Engineer, Clay Electric Cooperative, Inc.

You don't "just burn" residual fuels: You have to live with the problem. These fuels, depending largely upon the source of crude, will vary widely in composition. Engines vary too. Nearly every installation will require some "tailoring" despite the best attempts at an original sound engineering approach. Here is a report on one such installation and the evolution of a satisfactory system to handle the particular residual fuel available locally. The substantial savings possible make it all worthwhile.

This report covers information gained from actual experience with continuous use of Bunker C, or heavy residual fuel. Emphasis is placed on "continuous use" because many troubles have arisen quite unexpectedly where no trouble has been encountered for many days under the same conditions.

It is a report made up from day-to-day happenings at the Keystone Heights plant of the Clay Electric Cooperative, Inc. of Florida. In this plant are five Cooper-Bessemer engines. Three are turbocharged, 15- by 22-in units rated 1450 hp at 300 rpm. The two remaining are naturally-aspirated, 13- by 16-in units rated 670 hp at 400 rpm.

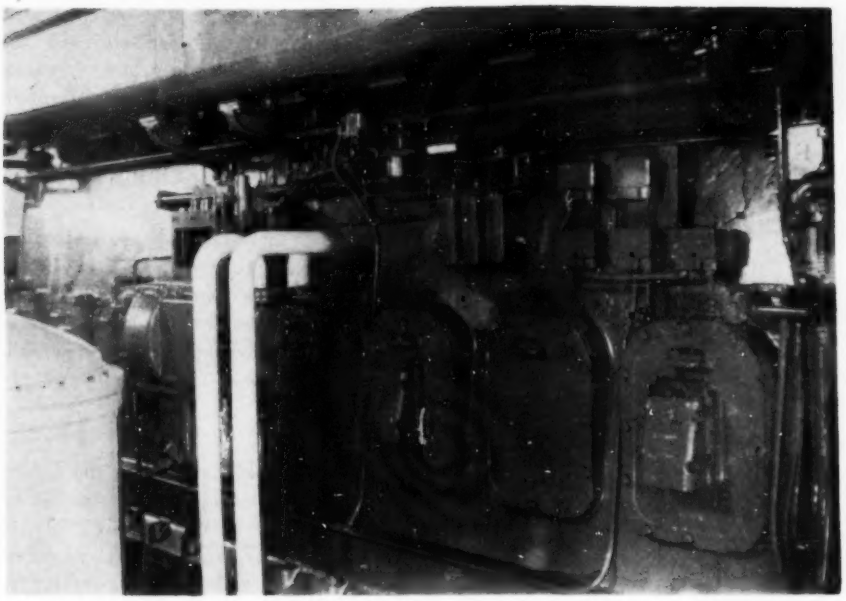
Use of a residual fuel, not blended with light fuel oil, was decided upon as an economic measure. After some of the "bugs" were worked out, substantial savings were realized. The gross profit has been 4 mills per kwh. Figured as the difference between the costs of the heavy fuel and light fuel, it has amounted to $3000 to $4500, depending on the output of the plant per mo. This is well worth saving if the troubles that threaten to eat up this saving are controlled or eliminated.

Fuel and Preparation

The heavy fuel used varied in specification. Viscosity ran from 110 to 166 Furol at 122°F; API gravity varied from 13.5 to 9.4; Conradson carbon ranged from 8 to 12 per cent; and, pour point was about 30°F. Sulfur has been low, about 0.6 per cent, but high enough to quickly eat up fine copper screens.

Cleaning and heating were the only preparations made. The general arrangements are shown in Fig. 1. The fuel is pumped from storage, heated within a range of 170-240°F, and centrifuged. It then goes to the make-up tank. Further cleaning in the form of filtration takes place later in the system and will be discussed in due course.

Solid materials in the fuel can be easily removed by centrifuging. Water is more of a problem. The specific



Entire system for distribution of light and heavy fuel seen mounted on the side of one engine. The three filters seen are for light fuel. Two check valves, both visible, are used to admit light fuel when heavy fuel pressure drops.

gravity of the fuel is so close to that of water that centrifugal removal was not possible. Removal by heating was found to deteriorate the fuel to the point that it would not pass through the strainers. However, water was the cause of needless worry and work. It was found that the engines would tolerate a small percentage provided that it was well emulsified with the oil and not in slugs.

From the centrifuges, the oil flows by gravity to the make-up tank. A continuous slope in the piping was found to be necessary. Otherwise, air, apparently entrained in the centrifuges, collected in large bubbles and stopped the flow, causing the centrifuges to "boil over".

It was also found that when a considerable amount of hot fuel was circulated through the make-up tank, serious foaming occcurred. This foaming was not steady but occurred explosively at intervals of days or weeks. The 1000-gal tank would be only about ¾ full, but when the foaming occurred, upwards of 50 gal of hot oil was thrown from the tank with considerable pressure. This trouble was ended by holding the tank temperature below 200°F.

Distribution to Engines

The system for burning heavy fuel was first applied to the three larger engines. In essence, the heavy oil was to be pumped through heaters and filters to headers supplying the engines. For starting, stopping, and possible emergency use, a supply of light fuel was also necessary. Three-way valves permitted selection of the fuel to be used.

Many unforseen complications arose, resulting in four variations in the system for supplying the heavy fuel; but before going into these, there are some general points pertaining to heavy fuel systems that bear elaboration.

Filters

Before any discussion, remember that we are handling heavy oils at relatively high temperatures in a pressurized system. By and large, these filtering problems are unique and relatively new. Therefore, the filter elements are operating outside the conditions for which they were designed and evaluation must be on an entirely different basis.

Two major problems arose: shrinkage and difficulties due to water separation. With respect to the latter, it has been noted that water would be present in the fuel to some degree. One type filter was apparently very efficient in removing the water and whatever the action, the element soon ceased to pass fuel at any reasonable pressure differential.

Shrinkage occurred in most types of filter elements but in varying degrees. In most cases, shrinkage was greater than the unit was built to accommodate, and they failed because of lack of end-pressure on the stack.

We have found that two types which are supposed to be shrink-proof also shrink, but within reasonable limits. We have made special holders to retain them. Both types have shown a life of from 72 to 450 hr at 1-gpm flow for the 9¾ by 2¾-in tube size cartridge.

Switching Fuels

Three-way valves for fuel selection seem to be the most handy device. In actual practice, they proved to be the cause of many plant outages, sometimes of embarrassing duration. The heavy fuel is pumped by electric motors taking power from the outgoing lines. Thus, when faults occur on the lines, the pumps stop and starve the engines just when they need extra fuel to produce the over-currents necessary to open the breakers and disconnect the faulted line.

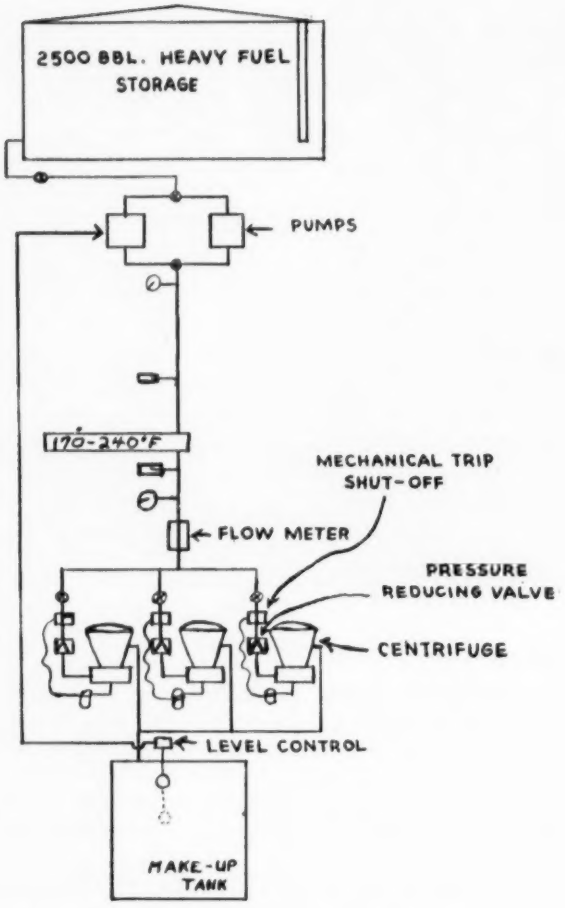


Fig. 1 Schematic diagram of the system for cleaning the heavy fuel. Note the use of pressure reducing valves for maintaining a balanced flow to the centrifuges. Make-up tank provides a reservoir of fuel for the distribution system.

With the manually-operated 3-way valves, an alert operator can sometimes change over one engine to light fuel before the engine fuel pump vapor locks; but the plant goes off the line when a serious fault occurs. The remedy for this situation is to use a check valve to admit the light fuel.

Each engine, through its own transfer pump, pumps and maintains the proper pressure on the light fuel. The heavy fuel has to be supplied at a higher pressure than the light fuel to produce equal engine performance, due to its higher viscosity. Thus, when the heavy fuel is being used, the greater pressure holds the light-fuel check valve closed, preventing the mixing of the two fuels. When the heavy fuel pressure drops as in the case mentioned, the light fuel pressure will unseat the check valve and flow into the line. In this way, the engines never fail for lack of fuel.

Draining Lines

Another point concerns the draining of the lines after switching fuels. At first, the drainage was switched back and forth so that the unused fuel drained from the engine, returning to the system from which it came. This is no longer done. Light fuel drainage from an engine running on heavy fuel is far too contaminated to be returned to tanks where light fuel must be kept clean and in good condition for long periods of time.

On the other hand, the small amount of light fuel returned to the heavy fuel make-up tank has caused no trouble. Such troubles as did occur—vapor lock in the heavy fuel pumps and excessive foaming—could not be traced to any mixture of the fuels. These troubles occurred so long after any mixing that the fuel mixture had been consumed and replaced.

Heat Loss on Switch-Over

In changing over from a cold light oil to the heated heavy fuel, it was found advisable to have the heavy fuel pass through a minimum of cold piping. Oil has only about half the heat capacity (specific heat) of water. Consequently, it cools rapidly with a corresponding increase in viscosity.

The same situation to a lesser degree can exist when part-load conditions prevail and the flow to the injection pumps is small. The small flow may not carry enough heat to warm the pump and maintain the desired viscosities. These difficulties can become troublesome unless the pump can handle the fuel at low temperature regardless of load.

No trouble has been found in changing back to light fuel. There has been no tendency toward vaporization due to high temperatures of the piping and equipment. Only a short run on light fuel is enough to purge the fuel system for easy starting. The operators shut off the heavy fuel a few minutes before going to the switchboard. They lower the load slowly to zero, take the engine off the line and shut it down with no idling period.

The engines have been started with no difficulty when accidentally shut down on heavy fuel. However, this is not good practice because the high-pressure pumps hammer if the engine is allowed to come up to speed on unheated heavy fuel.

With these general observations, we are ready to discuss details of the various systems tried.

First Try

The first system for feeding heavy fuel to the engines was notable perhaps for its over-complication. With this arrangement, the engine transfer pump circulated whichever fuel was selected through a circuit on the side of the engine. Selection was by means of a 3-way valve.

In the circuit there was a service or pressure tank, a steam-to-oil heat exchanger, a set of filters, and a relief valve. Because the heavy fuel was admitted at a much higher pressure than the light fuel, the engine did not perform equally on each fuel. The hot transfer pump was a burn hazard. Even with that, the temperatures could not be maintained at the desired level as heat losses exceeded the heater's input.

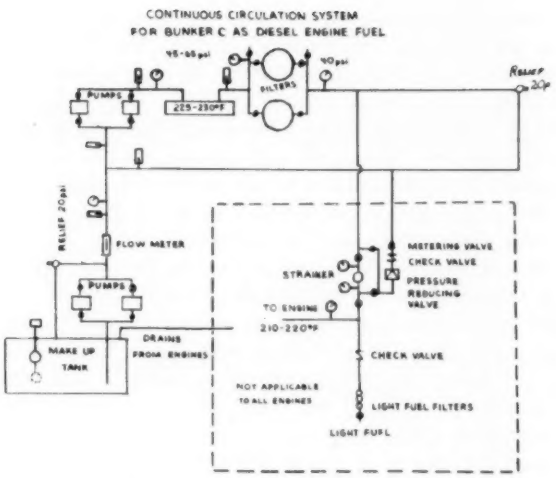


Fig. 2 Distribution system schematic diagram. It provides for continuous fuel circulation, final cleaning and heating of the heavy fuel. Headers are maintained at differential pressures with fuel being supplied to the engines at the higher pressure and the excess fuel returned to the lower pressure header.

Second Try

The next system retained all the components of the earlier one but instead of the circuit, the fuel made a single pass through the service tank, heater, the filters, and a strainer. It then reached the 3-way valve from which it either entered the engine or passed through a bleeder line to the drain. The drain discharged to the make-up tank.

The main difficulty encountered was carbonization of the heavy fuel in the heat exchanger under conditions of no- or slow-flow rate. The temperature controller turned on full steam pressure when there was no flow until sufficient heat traveled through the oil to satisfy the control bulb.

When the heaters were new, no trouble was noticed; but once they had become carbonized, new carbon films formed at an unbelievably fast rate, even after what seemed to be a thorough cleaning, if the oil was allowed to stop in the heater. After each cleaning, the heater was otherwise as efficient as when new.

The filters were removed because they created too much pressure drop far too soon. The engines require a definite pressure on the intake of their high pressure pumps. The filters showed no uniform life pattern that would permit periodic cartridge replacement, and sometimes the pressure drop across the filter built up quickly and starved the engine. However, removal of the filters did not end this starvation problem.

Some of the carbon produced in the heat exchanger was drifting downstream in the fuel, blocking the strainer. The strainers could not be removed from the system as they were catching other contamination as well as the carbonaceous paste from the heater. There were two effects: Due to the carbon film in the tubes, the heater failed to raise the oil to the desired temperature; and high pressure drop in the strainer lowered the delivery pressure. Both conditions contributed to engine smoking.

To overcome this problem, the "electric heat" system was devised.

Third Try

This system was tried on one of the 670-hp engines. A pipe was insulated electrically from the header that supplied heavy fuel to the three large engines. This pipe carried the oil to a 3-way valve close to the engine's high pressure pump. Only a thermometer, strainer, and bleeder to the drain were in the path of the fuel.

Heat was supplied electrically to the ¾-in pipe by a step-down transformer. One end of the secondary was connected to the pipe at the engine-end and the other to the pipe at the insulating flange, close to the header. A 350-amp current flowed in the wall of the pipe, the resistance of which produced the necessary heat. A thermostat, attached to the outside of the pipe, controlled a breaker in the transformer primary circuit. In this way the fuel was not exposed to excessive local heating and only the temperature necessary for good engine performance need be maintained.

As expected, this ended the carbonization trouble. The strainer remained clean and the engine ran very well. As we were making some changes on the larger engines (discussed later), this engine was run as much as possible. For five weeks no trouble developed excepting mechanical difficulties with the thermostat. We thought that we had the perfect system. Plans were made to install the same system in the Coop's second power plant at Worthington Springs, Florida. The other engines in the Keystone plant were to be converted. Arrangements were made, mtaerials purchased, and initial work started.

Meanwhile, the small engine was not operated so consistently and was shut down for days at a time. We thought that we had solved all the problems in feeding heavy fuel to the engines but, unknowingly, we were making the second half of the test for a really satisfactory system to burn heavy fuels.

After three weeks of running only when needed, the strainer could not be cleaned often enough to keep the engine running on heavy fuel. The check-valve system for admitting light fuel had been installed there were no engine failures from the blocking of the strainer. This clogging condition was unexpected since the larger engines were running continuously on the same heavy fuel, with no strainer trouble, from the same header that supplied it to the electrically-heated line running to the smaller engine.

Temperature conditions were the same and yet no blockage occurred in the large engines. The only difference in the systems was that fuel was continuously bled from the piping on the larger engines, even when shut down. But this feature was omitted on the smaller engine because the temperature was so easily raised by the electrical heating.

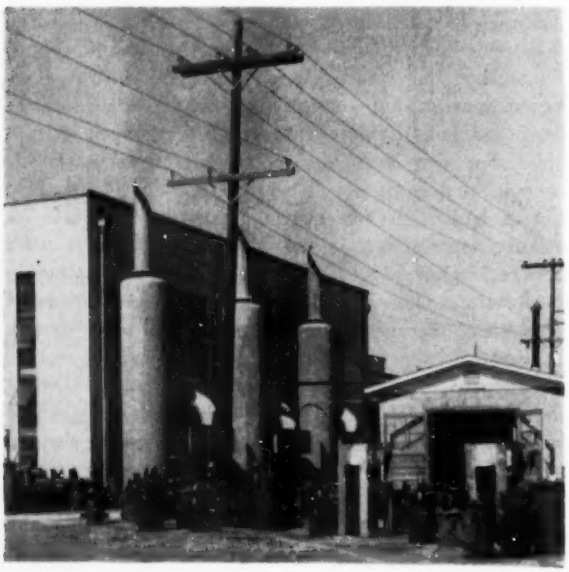
The excessive strainer blockage on the small engines was obviously due to a transformation of the fuel in the engine line during long shut-down periods. Blockage was

due to a smooth carbonaceous paste, probably caused through sludging or polymerization of the fuel. Apparently the heating, centrifuging, and then reheating, had caused it to make sludge, either so fast or of a kind that the strainer could not cope with it.

When this trouble was realized, all the work on electric heating stopped until we could take stock. Before going on to the next development, let's backtrack for a discussion of combustion problems.

Exhaust Smoke

Under all conditions, there had been some smoke from the large engines. This was thought to be natural when burning heavy fuel. It was black and heavy at light loads but cleared up to a haze at full load. However, one of the few pleasant surprises encountered in this work was that the small engine ran with a totally clear exhaust from low to full load and only had a hazy exhaust at overloads.



Rear of plant showing intake air filters and exhaust silencers. The three engines were running on heavy fuel at time picture was taken, illustrating the clarity of the exhaust. Small building is the heavy fuel processing house.

With evidence that heavy fuel could be burned with a clear exhaust over a wide range of load, we applied every effort to clearing up the exhaust on the three large engines. With the systems used, fuel was supplied to the engines at 270°F to 280°F. This, of course, was not the actual temperature of the fuel when injected into the cylinder because of heat loss in the pump, distributors, lines to the nozzles, and the nozzles themselves.

The small engine had a much shorter fuel system and so might have much less temperature drop. To find if this accounted for the difference, electric heat was applied to the fuel lines on one big engine so that the temperature of the fuel reaching the nozzle could be controlled.

No insulating material was used as in the case of the line supplying fuel to the small engine. We anticipated trouble if such material was to be exposed to the 6000 to 8000 psi pressure in the injection lines. The lines were left grounded at both ends. Retaining clamps, however, were insulated. A special transformer, producing four secondary currents, was arranged to heat all eight lines equally. By changing the amount of power applied, any desired temperature could be obtained.

It had been found that when fuel was supplied to the big engines below 270°F, they smoked appreciably at full load and very badly at half load. When the oil supplied was raised to 280°F, the smoke cleared to a haze at full load. When heat was applied to the injection lines, it was found that heat loss in the injection system was not the determining factor with regard to smoke. Temperature alone could not clear up the exhaust. All that it made possible was the operation of the engine at lower loads with the same hazy exhaust characteristic of full load.

With the temperature effect eliminated, it was reasoned that the difference between operation of the two engine sizes must lie in the proportions of the fuel system. The design of the two fuel injection systems is the same and many of the parts are interchangeable. The main difference was in the size of the nozzle orifices which are very much smaller in the smaller engine.

A reduction of 0.002-in in the orifice size proved to be the answer. With these nozzle tips, the exhaust of the large engines became absolutely clear from half to full load and only hazy down to quarter load. Also, it was found that fuel temperature to the engines could be lowered to 200°F without causing the engines to smoke.

With this background of experience, we were able to see where we were going and shape up the system that we are currently using with satisfaction.

Fourth Try

Our revised estimates led us to believe that the best system was what was left of our second try. The heaters and filters had been removed as mentioned before. Only minor changes were necessary and we would have just exactly what we wanted. The drains were giving trouble because the bleed-offs, circulating and keeping fuel hot during shut-downs, were overloading them and causing spills. Bunker C is messy to clean up.

Two headers are now used (see Fig. 2), forming a circuit or loop around which a pump cirulates the fuel. In the circuit is the pump; only one steam-to-oil heat exchanger which holds the fuel temperature between 220°F and 230°F; one small filter; and at the end furthest from the pump, a relief valve that bypasses fuel from one header to the other, set to maintain a 20-psi differential.

Piping is arranged from both headers to each engine, such that fuel from the high pressure header that is not used bleeds back to the low pressure header for re-circulation. Only a strainer, thermometer, shut-off valve, and the light-fuel check valve are at the end of these engine loops or drops.

(*Concluded on Page* 117)

Three Truck Loads in One

By Robert H. Forbes

Today, a large portion of our lumber industry is diesel-powered. PFI recently added five 100-ton tractor trailers to their diesel equipment for a 23-mi haul through the Idaho mountains.

At Green Creek Landing, one of the 100-ton diesel-powered rigs is having its 15,000 bd ft load transferred to smaller highway trucks in previously prepared 5000 bd ft bundles.

Nearly all logging and lumber companies in Idaho's panhandle country use diesel-powered equipment for some phase of their operations. Diesel tractors, trucks and locomotives play a big part in hauling logs from stump to sawmill. Potlatch Forest Inc. operate three large sawmills located near the northern Idaho towns of Coeur d'Alene, Potlatch and Lewiston, and use a large percentage of dieselized equipment.

Not too long ago, PFI, as the firm is known all through the area, was confronted with a problem of getting logs from company Camp 58 to railhead at Stites, Idaho. During the winter of 1950-51, a series of conference between woods operations and mechanical departments of PFI were necessary to lick the tough problems of transporting logs to the Lewiston operation.

PROBLEMS—Trucks would have to start with their loads of logs at an elevation of 4300 ft and climb a 4650-ft saddle. From this summit, the road dropped down to state highway 13 at Green Creek landing located on the south fork of the Clearwater River, an elevation of 1700 ft. This represented a 23-mi haul over private roads. Trucks selected for this haul would be required to have ample power and good brakes, even though corkscrew curves limited speed to 10 or 12 mph.

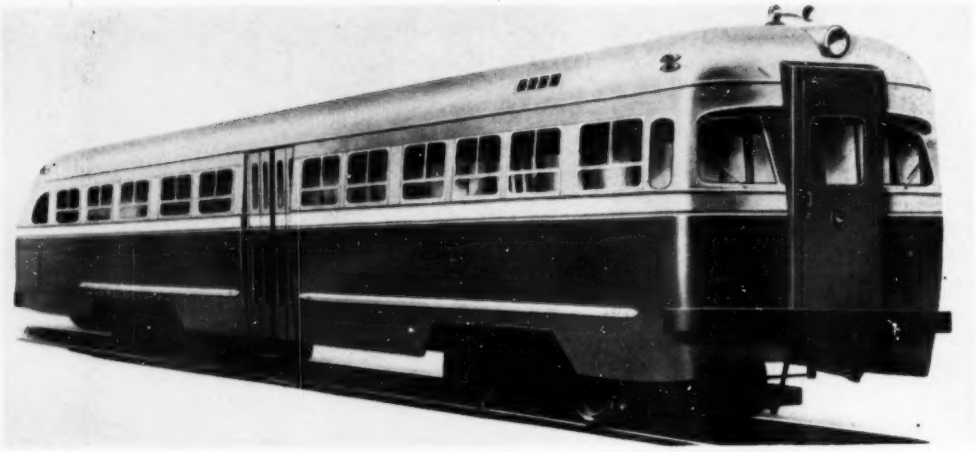
The 10 mi of road between Green Creek and Stites posed another problem to be considered as this final run to the railhead was state highway and not private road. Here, length and load limits would enter into the picture. It was decided that Green Creek landing would be a transfer point and special trucks would be used for the 23-mi off-highway haul.

Five Peterbilt Model 390 trucks, equipped with hydrotarder and 16-ft-wide log bunks, were selected for the job after a thorough investigation of all available trucks. These 100-ton giants, each with a 300-hp Cummins diesel supercharged engine, Model NHRBS, have now been hauling loads of 15,000 board ft of logs at a time, from Camp 58 to Green Creek landing for 10 mo.

At Green Creek, each big truck's 15,000-board-ft load is transferred in three previously prepared packages of 5000 board ft each, to smaller trucks for the short highway haul to Stites. Five thousand-ft log bundles comply with the state highway limitation of 68,000 lb gross.

Transfer of loads at Green Creek necessitates a derrick with a Caterpillar diesel power unit—a 105-ft mast and 90-ft boom, the whole being guyed by eight cables 250-to 350-ft long. The cables, spreading out from the top of the mast like streamers from a May pole, required special anchoring into rocks of the South Fork canyon. Hairpin-like rods, 10-ft long, were attached to each cable and then sunk into 2-in by 10-ft holes drilled in the rock.

An ordinary cement could not be found that would positively hold up under the 26,000-lb tension imposed on the anchors. Therefore, molten sulfur was poured into the holes to fuse hairpins to the surrounding rock. This anchoring method has proved a success.



At left is an artist's conception of the new 50-passenger, diesel-electric rail bus now in production.

Mack's Diesel-Electric Rail Bus

Latest addition to Mack's line of trucks and buses is the new model FDC Rail Bus, designed for short-haul branch and feeder line service.

If railroads could lick the problem of feeder line service, their overall operating economy might show considerable improvement. Branch lines often tie up large locomotives, representing a large capital investment, when only three of four cars are needed to handle light branch line loads. Operating large locomotives in this type of service is expensive and an inefficient utilization of power. With this problem in mind, Mack engineers are offering the new 50-passenger FDC Rail Bus as a possible solution.

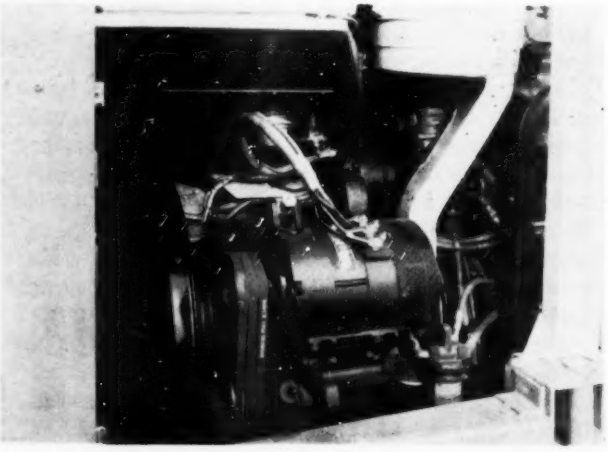
Outward appearance of the self-propelled rail unit closely resembles that of a large bus with trucks substituted for wheels. Other apparent differences that are noted on second glance are the headlights at either end and the single center door on each side. The interior, although still resembling that of a bus, looks more like a rail car as seats are reversible to permit operation in either direction. Units may be operated singly or in pairs.

Duplicate controls are located at each end. In dual-unit operation, one engineman can control both cars from either end. A lever at the right side of the control point regulates speed, and a foot pedal actuates the air brakes. An integrated speedometer and odometer are mounted on an instrument panel along with an air pressure gauge and a standard indicating lamp cluster. A sander control is located at the left.

When operating these units singly, speed of up to 54 mph can be obtained. During two-unit operation, a top speed of 61 mph can be reached in 3 min. To assure quick, safe stops at all speeds and under any rail conditions, air-actuated wheel tread clasp type brakes are used.

Braking air is supplied by two engine-driven rotary air compressors, designed to produce more than an adequate amount of air during normal operating conditions.

A close-up of the generator compartment shows the compactness with which accessory equipment is arranged.



Should trouble develop in either compressor, the closing of a single valve will cut it out of the air circuit. The remaining compressor will continue to deliver an adequate amount of air as either unit is capable of meeting air requirements for normal operation.

Should two cars separate during dual operation, brakes are automatically thrown into emergency operation and air is applied at a pressure of 85 psi in place of the 45 psi service pressure. The air brake system is further protected by an automatic high pressure safety valve, a low pressure buzzer, and a check valve between the second and third air reservoirs. The single check valve prevents loss of air in the event of damage to a compressor discharge line. Now, let's take a look at the power train.

Basically, power train design is the same as that for a diesel-electric locomotive in that an end-mounted 200-hp supercharged Mack diesel driving a 300-v generator, supplies power to the four variable-voltage DC traction motors. The four 55-hp traction motors are mounted one per each axle, thus making all wheels drivers. The main generator is direct-connected to the engine through a flexible coupling of the laminated steel disc type.

Main generator ventilation is provided by a built-in blower. At the outboard end of the generator an anti-friction bearing is provided to support the armature shaft and 3-belt pulley driving the auxiliary generator.

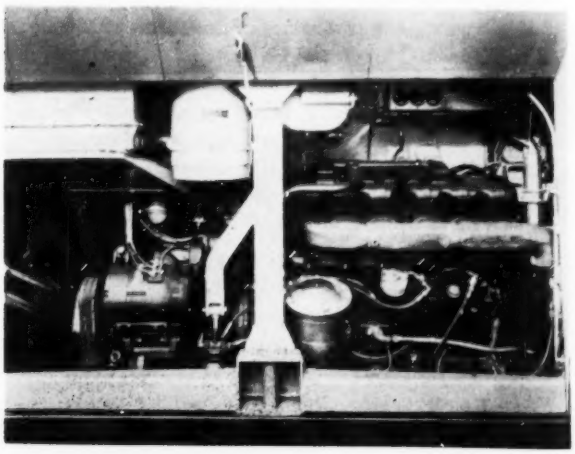
Power for the lighting system and battery charging is provided by the auxiliary generator. Equipment for this generator includes external current and voltage regulation, and a rectifier for battery charging. To assure positive cooling, the rectifier is mounted in the engine intake air system.

Starting motor power is supplied by two 12-v, 200-amp hr batteries mounted in separate compartments in sliding trays. The 24-v starting motor, driving through a Dyer type drive, is energized by a series-parallel switch to obtain the 24 v required for starting. A generator interlock relay in the starting circuit serves as a safeguard against starter engagement while the engine is running.

In summarizing, it might be well to point out that since designs are much the same as those for a standard diesel-electric locomotive, these rail buses can be maintained by any personnel familiar with maintenance of a diesel locomotive. Backshops currently maintaining diesel-electric locomotives can also maintain these units, thus incurring a minimum of expense in tooling and training personnel.

Units of this type may to a great extent, help to increase branch and feeder line revenue through lowering operating expenses and affording passengers with quicker, more comfortable service.

Engine-generator compartments are located in one end of these units much the same as a rear-mounted bus engine.



What Do You Know?

Here are more questions to test your general knowledge of the diesel field. Make your selections, then turn to Page 123 to check them.

1. Which of the following is a major difficulty in the removal of contaminents, including water, from heavy fuels with low API gravities in preparation for burning in engines?
   a. High viscosity
   b. High degree of contamination
   c. High specific gravity

2. When burning heavy residual fuels, it must be expected that engines will smoke — at least at part-loads.
   a. True
   b. False

3. Molybdenum disulfide, a solid-film lubricant, is becoming more popuar. One of the principal characteristics to look for before using it is:
   a. The type of carrier used
   b. Its purity
   c. Its geographical source

4. You can't go wrong with molybdenum disulfide. For example, mixed with engine lube oil it reduces friction throughout the engine. There is no problem.
   a. True
   b. False

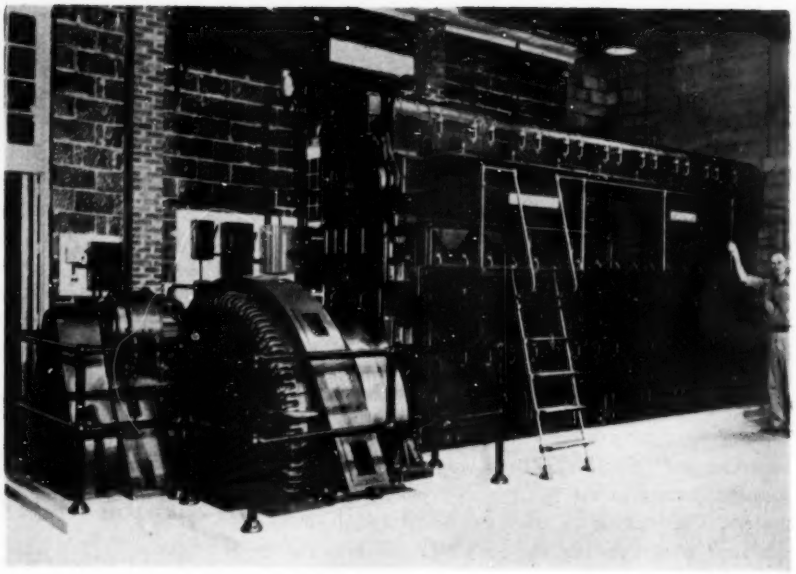
5. Which of the following is the principal reason for increasing the horsepower in trailer tractors?
   a. To increase the maximum speed obtainable
   b. To permit maintenance of higher average road speeds
   c. To increase the payload hauled

6. The general principle of wheel slip detection devices on diesel locomotives is to indicate differences in axle speeds. In every case of wheel slippage, the wheel slip light signal gives engineman warning.
   a. True
   b. Partially true
   c. False

7. With dual-fuel engines in power generation service, "meter swing" is a more common problem than with all diesels. One reason for this is:
   a. Longer delay in response to governor changes
   b. Amount of gas between control point and cylinder

8. Detonation in dual-fuel and gas engines can frequently be controlled by lowering scavenging air temperatures.
   a. True
   b. False

Latest addition to the Woodsfield municipal plant is this Superior model 80 dual-fuel engine, capable of developing 875 hp at 327 rpm.



Woodsfield, Ohio Cuts Cost With Dual-Fuel

By L. W. Marples*

Wherever natural gas is being made available, this economical fuel can be used to advantage. Here is another dual-fuel installation cutting costs for a municipal plant.

Fuel costs have been cut in half at Woodsfield by the installation of a dual-fuel engine in its municipal generating station. The new unit is a National Supply model 80, 8-cyl, 14½- by 20-in Superior engine with a rating of 875 hp at 327 rpm. The unit is direct-connected to a 600-kw generator. Major fuel is natural gas supplemented with 10 per cent pilot oil for ignition.

Woodsfield was in the electrical utility business long before 1920 when a steam engine driven generator served the village power requirements. At that time, the small community was not completely wired for lighting and power was supplied only from 6 am until 8 pm each day.

Subsequent to 1920, promotion of electrical appliances for household use became active and consumption of electricity increased rapidly. With peak loads steadily rising, original generating equipment was soon outdated and plans were promptly drawn up for a power plant having greater generating capacity.

Expansion

In 1922, two 220-hp semi-diesel engines were installed; each one direct-connected to a 136-kw generator. Then in 1935, a third unit, a 350-hp open-head type full diesel direct-connected to a 235-kw generator was installed. After operating with this equipment for 10 years, Village officials investigated community requirements and decided on replacing the two semi-diesels with full diesels having more power and a higher efficiency. In 1946, one of the units was replaced wtih a 300-hp "Backflow" type diesel engine direct-connected to a 200-kw generator; and in 1947 the second engine was replaced with a similar unit.

Loads continued to grow from both residential consumers and small industries served by the plant. Three feed mills require about 155 kw, while the water purification plant operates motors of 75 and 50 hp respectively, and the sewage disposal plant has a load of 20 hp. As shown in the accompanying table, peak demands in 1922 amounted to about 100 kw for which the two 136-kw units were installed. By 1934 and again in 1945, the demand exceeded the plants safe capability (allowing a capacity equal to the largest unit for reserve), and expansion followed.

A similar situation existed in 1948, and by the latter part of 1949 all of the units were operated over the peaks, which ranged from 520 to 560 kw. Any form of failure in the equipment meant a power loss to at least half of the town as the plant distribution system operates on two circuits.

Dual-Fuel Installation

Faced with these steadily increasing demands, the town purchased the dual-fuel engine in 1950 and had it in oper-

* *Plant Superintendent, Woodsfield, Ohio*

An exterior view of the Woodsfield plant which has a total capacity of 1235 kw.

ation the latter part of December of the same year. It can burn either oil or natural gas with equal facility and efficiency and develops the same hp rating on either fuel. Fundamentally, the engine simply substitutes a portion of gaseous fuel mixed with air for a corresponding amount of liquid fuel and continues to operate on the diesel cycle with compression ignition.

The gas-air mixture is compressed and ignited or "fired" by a pilot charge of fuel oil, which is introduced at the proper time by the injection system. Gas consumption varies from a few per cent at idling to over 90 per cent of the total fuel at full load. Actual ratios and economy will accordingly vary with engine loading.

In dual-fuel operation, proportion of gas to pilot-oil injected is automatically controlled by the governor. For example, if gas is not available, or if the supply is not sufficient for the load, the governor will permit burning all the available gas and automatically make up the balance of fuel requirements through additional oil injection above ignition requirements. If such action occurs, an alarm light on the control panel comes on to indicate that the engine is consuming fuel oil in excess of normal pilot requirements.

A direct driven pump, mounted on the engine, takes lubricating oil from a 450-gal underground sump tank and feeds it through filters, coolers, and a Purolator, before it reaches the engine header. Jacket cooling water flows through a closed system which incorporates a Marley cooling tower.

Fuel oil, stored in an 18,000-gal tank behind the power plant, is pumped through filters on its way to two 300-gal underground day tanks. From here a manifold pump supplies the engines direct through another set of filters. Natural gas comes to the metering house at 40 to 50 psi where pressure-reducing valves lower it to 12 and 4 psi consecutively for use in the engine.

At the present time, the Superior carries the entire load during the day from 9 am until 11 pm, and two of the 200-kw units handle the night load, which averages about 170 kw. In the past, when one of the industrial plants came on the line, lights would dim throughout the community; but since the new unit was put into operation, the oncoming loads are picked up without disturbing system voltage.

Economy

Gas is purchased at 37 cents per thousand cu ft and latest figures indicate the engine operates at about 4.8 mills per kw (3/5 load), whereas the older engines operate on straight diesel oil at a cost of 9.5 mills per kw (¾ load). These figures readily indicate that the new engine operates at exactly one-half the cost of the older units, a tremendous saving for the community.

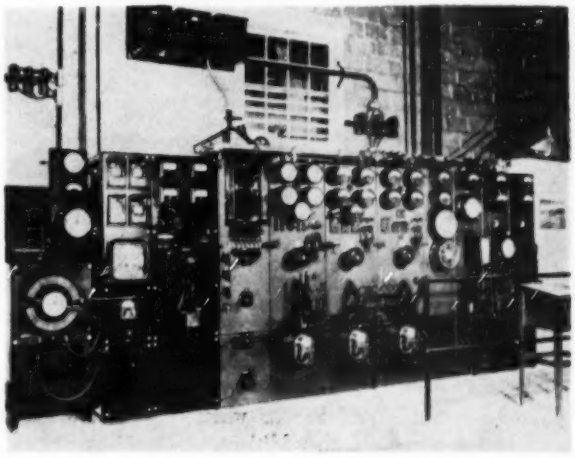
System Load Growth

Year	*Peak KW Demand*	*Plant Capacity**
1922	100	136
1934	172	136
1935	190	272
1945	310	272
1947	390	400
1948	410	400

**Plant capacity is figured on the basis of allowing a capacity equal to the largest unit for reserve.*

Principal Equipment

Dual-Fuel Diesel	Engine Division, National Supply Co.
Generator	Elliott Co.
Governor	Woodward Governor Co.
Silencers, Intake and Exhaust	Maxim Silencer Co.
Injection Pumps	Scintilla Magneto Div.
Fuel Oil	Standard Oil Co.
Transfer Pumps	George D. Roper Co.
Fuel Meters	Buffalo Meter Co.
Fuel Oil Filters	Purolator Products, Inc.
Lube Oil Filters	Fram Corp.
Oil Cooler	Ross Heater and Mfg. Co.
Water Pumps	Weinman Pump Mfg. Co.
Air Filters	Air-Maze Corp.
Air Compressor	Quincy Compressor Co.
Control Panels	The National Supply Co.
Exhaust Pyrometer	Alnor, Illinois Testing Laboratory
Switch Board	Lake Shore Electric Mfg. Co.
Voltage Regulator	Allis Chalmers Mfg. Co.



Electrical generation and distribution is handled from this switchboard, with section for the new engine at the left

DIESEL BRIEFS

New Oil Well Acidizing Rig

Operators of oil well acidizing equipment have had to design more powerful pumping units to keep pace with drillers who are constantly sinking wells to deeper and deeper levels. Such a rig will be exhibited by Dowell, Inc., subsidiary of the Dow Chemical Company, at the International Petroleum Exposition in Tulsa.

Wells over two miles deep are being acidized successfully today, but this firm now has a rig with sufficient power to operate at even greater depths and pressures than those now generally encountered. Illustrated is a unit recently put into operation which was designed to deliver 70 gal of chemical per min against a pressure of 7500 psi.

In providing the greater pumping power, care had to be taken to preserve the mobility of the rig. A GM Twin-Six diesel engine was selected. It weighs less than 6000 lb and measures 72-in by 54-in overall. Representatives of the Diesel Power Company, distributors for Detroit Diesel engines in Tulsa, engineered the power plant to do the job and helped work out assembly details.

Underground Storage System

A new development in underground oil storage, now in use in Sweden, is being considered by American oilmen. The system, called "Edholm Container", is said to be economical and efficient. It employs water pressure to seal an underground storage cave and prevent loss of stored oil. The cave must be below the water table level. The method is said to be useful for virtually all types of petroleum products storage with the possible exception of lube oils which may contain water-soluble additives.

SES Elects Healy President

William L. Healy of General Electric has been elected president of the Standards Engineers Society for 1953. The Society was first organized informally in 1947 to act as a medium for exchange of standardization ideas and techniques.

AIEE Boston Meeting

The Boston Section of the American Institute of Electrical Engineers will play host to the North Eastern District Meeting on April 29-May 1, 1953.

Diesels Net Montreal Profit

Montreal Locomotive Works, Ltd. earned a net profit in excess of 1951 figures, it was revealed. It was reported that manufacturing operations in 1952 had been at the highest level enjoyed by the company since it began converting to locomotive production.

In an annual report it was stated that deliveries of diesel parts increased substantially, reflecting the growing number of diesel-electric locomotives in service. Current backlog includes orders for 79 diesel-electric locomotives.

Petroleum Industry Fair

The International Petroleum Exposition to take place in Tulsa, Oklahoma, May 14-23, will feature advancements made in equipment and services from 1948-1953, since the time of the last exposition. Hundreds of exhibits in exploration, drilling and refinery are scheduled along with production, pipeline and scientific exhibits.

International Buys Hough

The International Harvester Co. announces that it has acquired the stock of the Frank C. Hough Co. of Libertyville, Ill., manufacturer of earth-moving, excavating, and material handling equipment. The Hough company will become a wholly owned subsidiary, with Frank C. Hough continuing as president.

Fluid Power Controls Course

An advanced course in fluid power controls, designed especially for engineers whose work is in the field, will be given from July 6 to 17 at the Massachusetts Institute of Technology. Highlights of the program will include discussions of fundamentals of fluid flow, new concepts of flow valve performance and design, and the generation and utilization of compressible and incompressible fluid power.

DIESEL BRIEFS

GM Diesel Engine Operations

Market for products of the General Motors diesel engine divisions continued very active during 1952, as revealed in the corporation's annual report, just released. Electro-Motive, Detroit Diesel, and Cleveland Diesel, although handicapped by insufficient materials, produced 7.1 million diesel hp last year. In 1951 they produced 8.3 million.

Rapid increase in railroad use of the Electro-Motive factory rebuild service necessitated further expansion of facilities of the division's six factory branches and the purchase of a site at Salt Lake City for a seventh branch.

SAE Lubricant Developments

Two important developments with respect to lubricants have been announced by the Society of Automotive Engineers.

Revised copy for SAE General Information Report on Crankcase Oil Types has been prepared based on the new API classification system. The SAE Transmission and Axle Lubricant Classification has been revised to base it on viscosity only. Proper performance qualities for the service recommended, including low temperature characteristics, are the responsibility of the lubricants supplier.

More Diesels for So. Pacific

Plans for purchase by Southern Pacific of another 100 diesel locomotives, comprising 150 units with a total of approximately 225,000 hp, were announced by D. J. Russell, president of the railroad, following a meeting of the company's board of directors.

The new purchase will raise the road's diesel fleet to a total of more than 1400 units with an hp total of almost 2,000,000. Cost of the new diesels, it is reported, will raise to almost $200 million the line's investment in 1257 diesel locomotive units since the war.

Diesels Double B&O Net

The Baltimore & Ohio Railroad revealed that increased use of diesel power was a big factor in helping it almost double its net income in 1952. The road was able to increase its profit by saving about $16 million in expenses. "Most of the economies in operation," the annual report of the road states, "resulted from greater use of diesel locomotives, better yard facilities, and improved methods."

The B&O acquired 101 diesel units during the year and retired 266 locomotives. In the last five years, adding 546 diesel units has enabled it to scrap 894 steam locomotives, some more than 35 years old.

Dravo Bags Safety Award

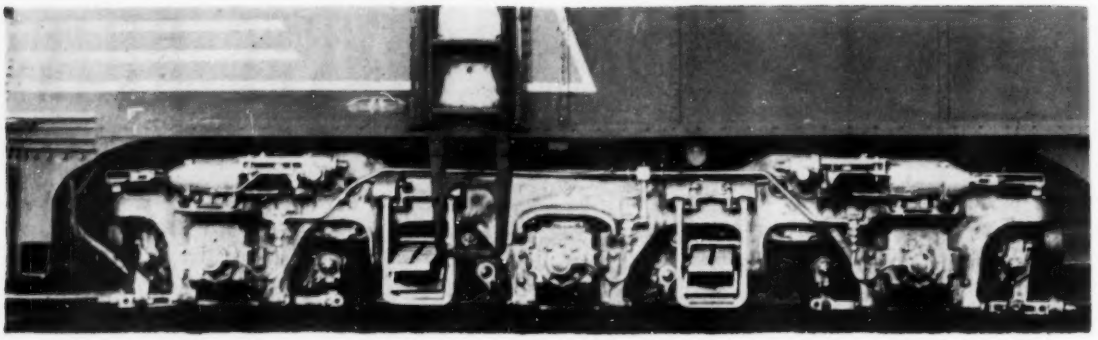
Dravo Corp. has received the National Safety Council's highest award for employee safety. The company won the award for its 1952 accident prevention record which was 50 per cent better than the 3-year average in the industry. It was one of the first company-wide Awards of Honor ever given by the Council to a firm in the heavy construction industry.

Larger "No Pushbeam" Bulldozer

Following the development of the "no pushbeam" bulldozer, The Baker Manufacturing Company announced production of a larger, more powerful dozer of a similar design. In cooperation with Allis-Chalmers tractor engineers, Baker has made the hydraulic bulldozer integral with the HD-15 crawler and named it the Baker "15X".

Development of first the 9X and now the 109-hp 15X called for a number of engineering design alterations from the long established ideas of how bulldozers must be constructed. Conventional pushbeams as well as much unnecessary weight was eliminated by the mounting-lifting arrangement which proved successful in the pioneer model 9X.

The tractor mainspring has been removed, with the entire front tractor frame and integrally bolted dozer attachment being supported by twin hydraulic cylinders. Stabilizer bars connected to the hydraulic pistons and running from track to moleboard absorb torsional strain and reduce horizontal forces on the tractor frame.



Left side of No. 1 truck showing rotary switches and connections for 6-wheel truck.

New York Central Investigates . . .

Locomotive wheel slip or slide can cause serious damage to both the diesel locomotive and track if not checked. Presented here, are some results of recent tests conducted on the New York Central System with various wheel slippage controls.

EARLY in 1946, the New York Central System initiated an investigation on wheel slippage. This action was fostered by unexplained difficulties, flashovers, and other troubles experienced with tractive equipment, all of which pointed to wheel slippage as a contributing factor. Several indications of wheel slippage without wheel slip light illumination led to further investigation, which revealed a more complete picture of what actually was happening.

Preliminary observations were made of the ammeter which indicated a loss of power. Power was restored by momentarily reducing throttle position. This was an indication of wheel slippage although there was no wheel slip light signal. In other cases, wheel slipping was visually observed when there was no light indication. Severe rail damage has resulted in some instances where, unknowingly, enginemen have permitted wheels to slip while trying to start a train.

Examination of numerous tapes from recording speedometers (driven by power axles) on freight locomotives proved the obvious, the wheel slip relay then in use, failed to function during many wheel slips.

* *Abstract of a paper presented before the Locomotive Maintenance Officers Association, Chicago, Ill., by Fay Thomas, Assistant to the General Superintendent of Diesel-Electric Equipment, New York Central System.*

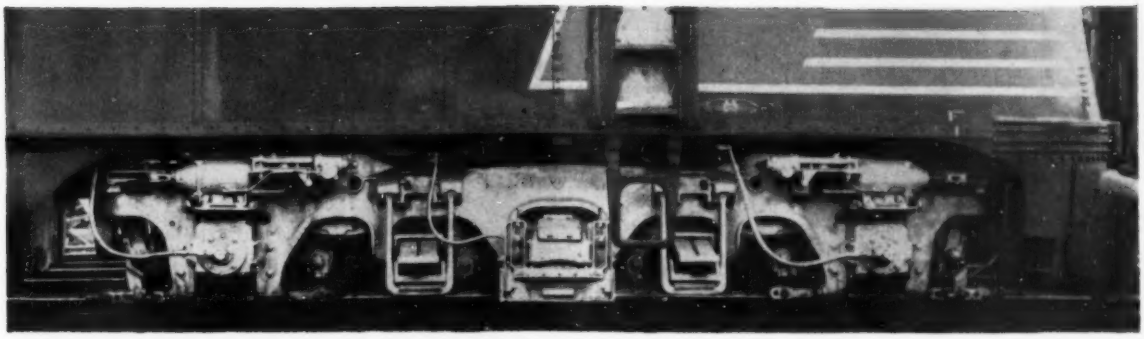
Progressive Steps of Investigation

1. Recording speedometer drive was changed from the idler wheel axle (usual connection in a 6-wheel, 2-motored truck) to the No. 1 power axle on each unit of a 2-unit locomotive. This change took place about Sept. 1948. Records of wheel speed obtained during next several months showed the extent of wheel slippage to be greater than anticipated. In numerous instances, slipping wheels spun to speeds in excess of the 120 mph that recorders were capable of registering. Continuous slippage at such speeds occurred for distances of 34 miles, as measured on tread of the slipping wheel. Recorder tapes showed a pair of slipping wheels traveled in effect as much as an additional 60 miles over a 146-mi division.

2. A second recording speedometer was applied to the No. 2 driving axle of each unit during March 1949. These recorders were equipped with another pencil to register operations of the wheel slip light circuit. Tapes from the second recorder showed that often the wheel slip circuit did not function when wheels were slipping and no wheel slip light warned the engineman. From a comparison of tapes from No. 1 and No. 2 recorders, it was determined simultaneous slippage of both pairs of driving wheels in the same truck frequently occurred.

3. In August 1950, recording speedometers were applied to the other two driving wheels of each unit. The records from all of the driving wheels on the two units gave a complete story of what happened in subsequent tests.

Throughout the investigations considerable work was done on a number of types of wheel slip relays and their connections. In fact, the New York Central tried all the wheel slip relay combinations suggested by manufacturers.



Right side of No. 1 truck showing recording speedometer drives for each axle.

Diesel Wheel Slip and Slide

*By Fay Thomas**

At one time there were more than 20 units operating with experimental wheel slip relays. While some improvements were attained in wheel slip detection during this period, the results were far from satisfactory and the conclusion tentatively reached was that the sensing of wheel slippage by relays in motor circuits is fundamentally unreliable for certain conditions, including wheel slide.

Investigation of various types of wheel slip relays had been underway for about four years when the Interstate Commerce Commission asked the American Association of Railroads, to investigate devices which would sound an alarm if a wheel became locked. This condition had caused several accidents. It was suggested that such wheel protective equipment should be independent of regular circuits on unit, so that wheel protection would be maintained at all times, even when the power plant was cut out.

In January 1950, the A.A.R. Electrical Section Sub-Committee went on record that: "It was the opinion of Committee that a device for protection of wheel slide should also incorporate protection for wheel slip, with a view not only to simplify equipment on the locomotive, but that a device actuated by the action of the wheel itself would be more reliable than the present type of wheel slip protection or other devices that are not directly actuated by rotation of wheel."

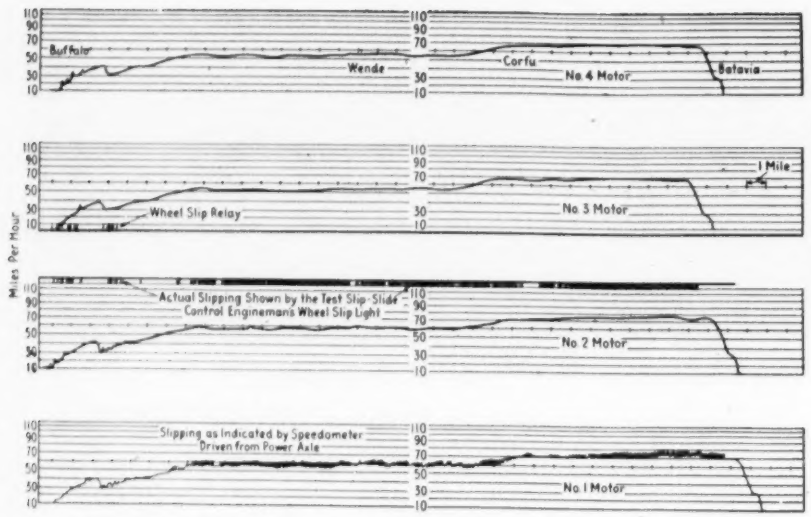
Wheel control equipment to protect wheels from sliding during braking, which had been used for a number of years on passenger cars, was one of the several devices suggested to the committees. It appeared that an adaptation of this wheel control equipment could be made to afford the desired locked wheel alarm for all wheels and an in addition provide an improved spin detection and an indication of wheel slide from braking. The New York Central agreed to apply that equipment to two diesel units for test and to report results to A.A.R. committees. The test of this equipment was considered a continuation of the original wheel spin investigation.

Tests were made in two parts. First, the wheel detection of slips and slides was recorded on speedometer chart by the wheel control device, but was not connected to actuate the locomotive slip control circuit. This proved the reliability of the device as all slips exceeding 7 mph were detected.

During a 6-mo trial period (Sept. 16, 1950 to March 26, 1951) on 173 runs over 1017 divisions, all slips—totaling 3919, were detected by test device. The regular slip relay of the newest type detected 1033 slips, or 26 per cent of the total, leaving the locomotive without spin protection for 74 per cent of the slips which occurred. In addition, the wheel control device indicated a case of locked wheels caused by an armature band wire failure and a case of sliding wheels due to braking.

The second part of test was made with the wheel control device connected to actuate the locomotive slip control circuit. Also in this phase of the investigation, several variations of the slip control itself were tried to determine what improvements, if any, could be made in the control of slips after the condition was positive detected by the wheel controller.

First, with the wheel control device operating in place of the regular wheel slip relay, but with the locomotive slip control circuit otherwise the same, records indicated that all slips were controlled before the wheel spin exceeded the rail speed by about 10 mph. The duration of a slip control was about 2 sec. Usually there was no op-



An example of excessive slippage corrected by the axle-driven wheel controller actuating locomotive wheel slip circuit in place of the regular wheel slip relays, but with circuits otherwise the same. This illustrates the tendency for slippage to occur under certain conditions as power is reapplied.

eration of the regular wheel slip relay, which was disconnected from the locomotive control circuit and attached to a pencil on the speedometer chart. This failure of the regular wheel slip relay to function probably was due in many cases to the prompt detection of the slip by the axle-driven device.

With this arrangement however, records showed that wheels often slipped again as power was reapplied after a spin correction. On one occasion, with the locomotive operating between 60 and 70 mph, it was necessary to control 296 slips in 28 mi. It was thought that this was due to the arrangement of the locomotive circuit which permitted reapplication of full power too soon after a slip correction.

Means were then applied to the locomotive circuits to momentarily reduce the power after a spin correction. This eliminated the tendency for recurrence of wheel slippage and still permitted prompt reapplication of power.

Control Systems

American Brake Shoe Company's 3 in 1 Wheel Control—Of the three systems selected for extended trial, tests covered in the foregoing have only been completed on this system, resulting in its approval. Equipment comprising this device is as follows:

A rotary switch, one on each pair of wheels; a relay panel, one per unit with one relay for each pair of wheels controlled; and a test switch, one or two per unit. Equipment is the same for an "A" or "B" unit. The same type of equipment can be applied to a unit having 4- or 6-wheel trucks, and a unit having 1 or 2 power plants.

The rotary switch consists of a rotor (brush holder) which turns with the wheel and wipes brushes in contact with a stationary commutator. The switch generates no current; it functions to pass a circuit from the battery to relay panel. It fits a standard mounting and drive on roller bearing boxes, applied at one end of each axle, and may be mounted on any of the several types of journal boxes when they are equipped with a mounting face and axle drive fittings.

A relay panel is connected to the control battery and should be located in or near an electric locker. Rubber shock proof mountings are provided inside the panel box. Each relay is double contacted and protected by a metal guard. A light on panel shows operation of the control circuit. A truck test switch provides means of routine inspection and check of device equipment.

The threefold functions of this equipment are: (1) to detect wheel slip promptly at all speeds and provide circuits which can be used for correction, thus protecting against motor damage due to high speed slipping and

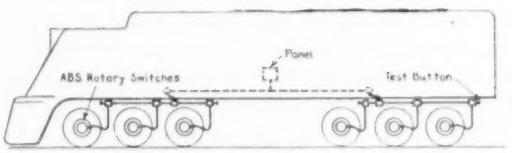


Fig. 1

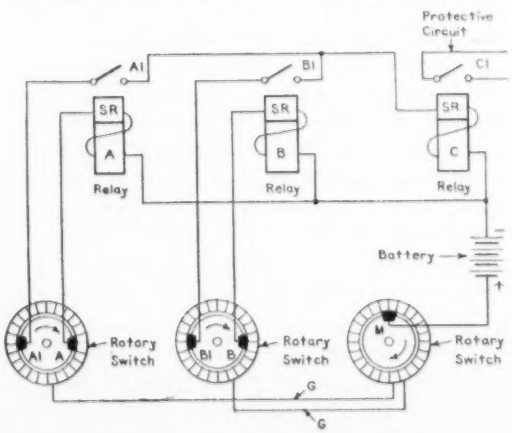
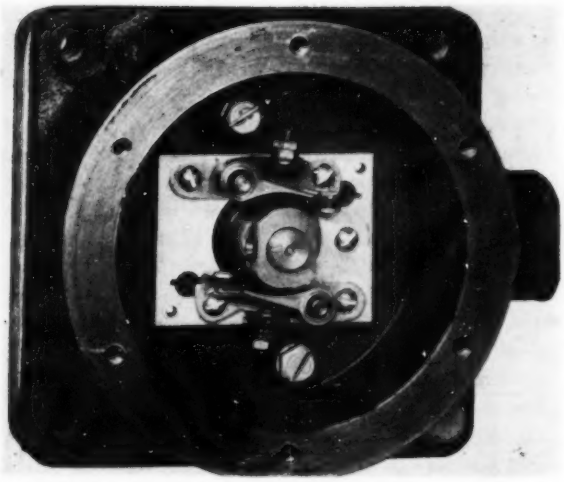


Fig. 2

Schematic of the ABS 3 in 1 wheel control system.



Illustrated above is the GE axle-driven switch unit, arranged for journal box mounting, with the cover removed.

flashovers; (2) detect slippage and sliding during braking, thus protecting wheels and other equipment against sliding or locking of wheels; (3) to close warning circuit and give continuous warning light if wheels become locked or a fuse blows.

Operation of the device is based on the fact that the wheels in the same unit rotate at substantially the same speed unless there is slipping at contact of the wheel and rail. The instant slippage begins, the pairs of wheels will rotate with an abnormal difference in speed, signaling the need for correction. The control or warning will begin when there is approximately 7 mph difference regardless of the speed at which the locomotive is being operated.

Control starts practically the instant slipping begins so that the protection or warning is immediate under all conditions. The controller circuit is independent of other equipment and functions even though the diesel power plant is isolated.

When a wheel slip occurs under operating conditions, power is removed through the regular wheel slip protection circuits, and the wheel slip light in the cab indicates the condition. With the final arrangement now in use, after slip is corrected, power is restored at reduced level. This is accomplished on earlier EMD equipment by the use of a duplex pilot valve and solenoid valve connected to the battery field contractor so that the load regulator tends to travel toward minimum field position during the slip period. On later Electro-Motive units this is accomplished through an overriding solenoid which is built into the governor, making any additional load control equipment unnecessary.

Up to Sept. 1952, the two units initially equipped with the ABS, 3-1 Control had been in operation for 578,000 and 621,000 miles respectively. These units have received only routine service attention which consists of trip inspections involving operation of truck test buttons and monthly inspections of axle rotary switches and relays. Time required is approximately 5 min per unit for trip, and 1 hr. per unit for monthly inspections.

Up to the time tests of this device were concluded, 5465 slips were recorded by the recording speedometers, all of which were detected by the device. In addition in the two cases previously mentioned, of locked wheels detected the device indicated the entire time the wheels were locked, whereas the regular wheel slip relay gave no indication.

General Electric's Wheel Slip-Side Control was installed Dec. 15, 1950 on one unit for service test information and is still under test. This device uses axle switches which contain cam actuated breaker points. The speed sensing unit which measures axle speed is essentially a switch which alternately charges a capacitor from a fixed voltage and then discharges this capacitor through a discriminating circuit. The number of times per second that this capacitor is discharged through the discriminating circuit is a measure of axle speed.

During the first six months of operation, the device was connected to operate only a lamp in the cab. During this period several changes were made which improved the life of the wearing parts and made the servicing of the equipment much easier. On June 22, 1951 four speed recorders were applied to the driven axles and connected with magnetically operated pencils to indicate when the device detected a wheel slip or slide. On December 21, 1951 the equipment was connected to control excitation for wheel slip correction.

After about six weeks of otherwise excellent operation it became apparent that the time delay relay used to provide the 15-sec lock-out feature was not satisfactory under vibration. About the same period the time delay relay began acting up due to rain water entering one of the disconnect plugs to an axle switch. This caused corrosion between contacts, which in turn caused a false indication resulting in a lock-out.

Since this equipment is virtually of the fail safe type, it registers a wheel slip for most any fault in the detection system and the locomotive cannot be operated with defective wheel slip detection equipment unless it is intentionally cut out of the circuit by the crew.

Difficulties previously experienced with this equipment have been overcome for the most part by the installation of a time delay relay with a capacitor charging characteristic. With timing element current changes, the contacts have since operated with a minimum of maintenance. Axle switch oil seals were also improved and the method of application modified.

Recording speedometer tapes indicated instances where a slip was detected and controlled by the apparatus, but the wheel slip relay would be released before the slip was completely arrested. In other words, before the wheel completely returned to track speed power was again applied. This action caused increased wheel spin until again detected as a wheel slip. This condition is not the same as that caused by the uninhibited reapplication of power initiating a new slip, but is merely the reapplication of power before the original slip has entirely disappeared. To correct this trouble, a time delay of approximately ½ sec was added to the drop out time of the detection

relay. Thus, complete recovery before reapplying power was insured. Generally, this resulted in wheel speed dropping to track speed before reapplication of power. Some slips occurred shortly after correction due to acceleration under poor rail conditions.

Design of this device is such that it will detect wheel slips to a speed of only 5 mph if the other wheels are at a standstill, or it will detect when wheel slips at a speed of 114 mph when other wheels are running at 100 mph. Thus, wheel variations may reach the extreme limits as specified by A.A.R. without receiving false wheel slip indications in the high speed ranges due to difference in wheel sizes.

On May 4, 1952 No. 1 wheel slid a short distance while making a station slow-down. Wheel speed dropped from approximately 18 mph to zero and then returned to 15 mph. This slip-slide control device detected this at once.

EMD's Modulated Wheel Slip Relay system was placed under test early in 1952. This arrangement was applied to a locomotive unit equipped with recording speedometers on all powered axles so that accurate information in connection with the functioning of this device could be obtained.

Briefly the functioning of this arrangement is as follows: The normal "C" clamp or through cable relay with which the unit was equipped, has traction motor armature cables removed and the potential coil which functions on difference in voltage of the two traction motor armature leads operates in series connection of traction motors only. Two additional through cable type relays were installed in each high voltage cabinet.

Armature cables are passed through the yokes so that current to the No. 1 and No. 2 traction motors for instance, flows in opposite directions. This results in the total field produced being canceled out when current in each armature lead is approximately equal. The two through cable relays are equipped with biasing coils energized across the main generator output. As the generator voltage increases the relay becomes more sensitive to a change in current of one of the through cables. With biasing voltage adjusted by use of a series resistor, it was found that any degree of sensitivity desired could be obtained.

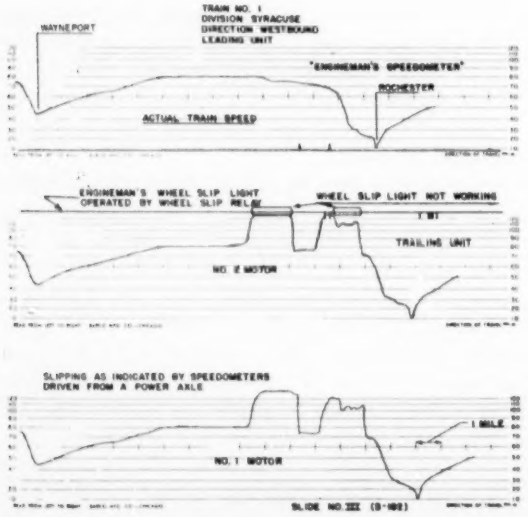
During the first part of test, the biasing coil was set to provide 0.22 relay amp turns per generator volt. Relay sensitivity was such that wheel slip indication was received when the speed recorder failed to indicate any change in wheel speed. Biasing was reduced to 0.2 amp turns per generator volt and satisfactory operation was obtained. This test proved that under these operating conditions wheel speed differential of from 10 to 12 mph was readily detected providing both power wheels driven by one power plant did not slip simultaneously.

In order to eliminate power plant unloading when very short fast slips occurred, which are normally self correcting, a time delay relay was introduced whereby operation of the wheel slip relay would start the load regulator toward minimum field. If slip was not corrected within 2 sec, field contactors were dropped out unloading the power plant. This arrangement performed very nicely and many slips have thus been self-healing before power was entirely removed from the traction motors.

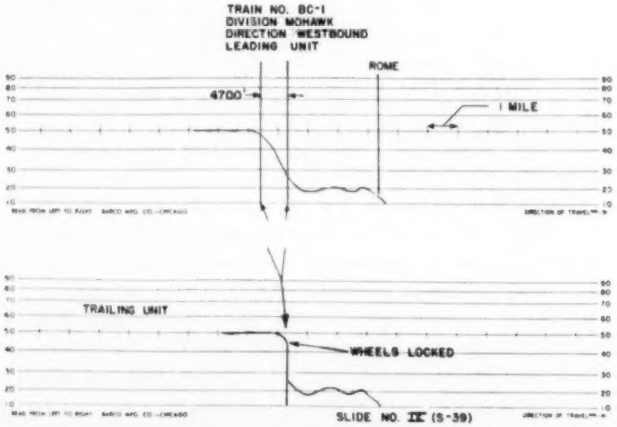
Summing up first portion of this test: wheel slip detection by measuring difference in motor current is satisfactory providing both traction motors do not slip at the same time. With a relay set-up as sensitive as this, false wheel slip indication is to be expected occasionally. No arrangement has yet been developed by the manufacturer of this device to indicate wheel slide with the power plant isolated.

The latest wheel slip device of this manufacture contains an arrangement designed to detect simultaneous slip of both power driven wheels by detecting high main generator output voltage. A locomotive unit equipped with this device was dispatched from a Back Shop on June 27,

(*Continued on Page* 108)



At the left is an example of simultaneous slippage of two motor driven wheels in the same truck. Tapes below illustrate an example of wheels locked during braking, possibly caused by simultaneous use of dynamic and air brakes.



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SYMBOL MEANINGS

M—Marine
S—Stationary
P—Portable or mobile
O—Own Manufacture
B—American Bosch
BS—Bendix-Scintilla
DM—Demco

A—Air starting
EL—Electric
G—Gasoline engine starting
H—Hand cranking
M—Mechanical blower
TC—Turbocharger

D—Direct reversing
S—Snow-Nabstedt
T—Twin Disc
C—Capitol
P—Paragon
W—Western Gear
F—Falk

American Locomotive Company
30 Church Street
New York, New York

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
9 x 10½	P	4	12	9 x 10½	1600	1000	B	EL	TC	..	..	..	..	..
9 x 10½	P	4	16	9 x 10½	2250	1000	B	EL	TC	..	..	..	..	..
12½ x 13	P	4	6	12½ x 13	660	740	B	EL	..	..	..	..	..	34000
12½ x 13-T	P	4	6	12½ x 13	1000	740	B	EL	TC	..	..	..	..	36000
12½ x 13	S	4	6	12½ x 13	540– 650	600–720	B	A	..	..	..	..	..	39100
12½ x 13	S	4	8	12½ x 13	720– 865	600–720	B	A	..	..	..	..	..	51500
12½ x 13-T	S	4	6	12½ x 13	810– 975	600–720	B	A	TC	..	..	..	..	40600
12½ x 13-T	S	4	8	12½ x 13	1080–1300	600–720	B	A	TC	..	..	..	..	53300

All stationary engines available as dual-fuel units with same ratings.

Baldwin-Lima-Hamilton Corp.
Hamilton, Ohio

Mode.	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
T-495-SA	M-S-P	4	4	9½ x 12	530– 700	720– 950	..	A-EL	TC	F	107	51	87½	19500
T-695-SA	M-S-P	4	6	9½ x 12	800–1050	720– 950	..	A-EL	TC	F	134	51	79½	22500
T-895-SA	M-S-P	4	8	9½ x 12	1060–1400	720– 950	..	A-EL	TC	F	161	51	79½	27000
606-NA	M-S-P	4	6	12¾ x 15½	540– 750	450– 625	B-BS	Air**	..	F	159	61	91	35000
608-NA	M-S-P	4	8	12¾ x 15½	720–1000	450– 625	B-BS	Air**	..	F	195	61	91	43500
606-SC	M-S-P	4	6	12¾ x 15½	950–1320	450– 625	B-BS	Air**	TC	F	158	83	91	36500
608-SC	M-S-P	4	8	12¾ x 15½	1260–1750	450– 625	B-BS	Air**	TC	F	195	86	91	45000
521SA	M-S	2	5	21½ x 27½	2400	257	B	A	..	D	267	80	148	170000
621SA	M-S	2	6	21½ x 27½	2900	257	B	A	..	D	304	80	148	209900
721SA	M-S	2	7	21½ x 27½	3400	257	B	A	..	D	341	80	148	228000
821SA	M-S	2	8	21½ x 27½	3850	257	B	A	..	D	378	80	148	256000
921SA	M-S	2	9	21½ x 27½	4350	257	B	A	..	D	415	80	148	285000
1021SA	M-S	2	10	21½ x 27½	4850	257	B	A	..	D	478	80	148	314000
1221SA	M-S	2	12	21½ x 27½	5450	240	B	A	..	D	552	80	148	370000
324DA	M-S	2	3	24 x 36	1585– 3000	100– 180	O	A	..	D	..	..	..	....
424DA	M-S	2	4	24 x 36	2115– 4000	100– 180	O	A	..	D	310	111	236	....
524DA	M-S	2	5	24 x 36	2640– 5000	100– 180	O	A	..	D	356	111	236	441000
624DA	M-S	2	6	24 x 36	3170– 6000	100– 180	O	A	..	D	402	111	236	514000
724DA	M-S	2	7	24 x 36	3700– 7000	100– 180	O	A	..	D	447	111	236	588000
824DA	M-S	2	8	24 x 36	4225– 8000	100– 180	O	A	..	D	492	111	236	661000
924DA	M-S	2	9	24 x 36	4750– 9000	100– 180	O	A	..	D	538	111	236	735000
1024DA	M-S	2	10	24 x 36	5280–10000	100– 180	O	A	..	D	583	111	236	808000

** *Electric starting in locomotive application. The suffix "DA" or "SA" indicates whether the engine is double or single acting. All models are direct reversible. All engines are designed with open type combustion chambers. All 21½ x 27½ engines are available as dual fuel units, and are direct reversing for marine propulsion service. Weights shown are approximate shipping weights of stationary type engines D.E.M.A. Standard Equipment.*

The Buda Company
Harvey, Illinois

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
1BD38	S	4	1	3⅞ x 4½	6.7	1800	B	EL	..	..	38⅝	22⅛	39½	795
2BD77	P	4	2	3⅞ x 4½	15.8	2000	B	EL	..	..	21⅞	22¾	30¾	500
2BD-77	S	4	2	3⅞ x 4½	13.4	1800	B	EL	..	..	39⅛	22⅛	39⅛	795
2BDM-77	M	4	2	3⅞ x 4½	15.3	2000	B	EL	..	S	37⅝	25⅛	31⅝	720
4BD-153	P	4	4	3⅞ x 4½	34	2400	B	EL	..	..	30⅝	22¾	30¾	680
4BD-153	S	4	4	3⅞ x 4½	28	2000	B	EL	..	..	50⅛	22⅛	39⅛	875
4BDM-153	M	4	4	3⅞ x 4½	33	2400	B	EL	..	S	47⅛	25⅛	31⅝	840
6BD-230	S	4	6	3⅞ x 4½	42	2000	B	EL	..	..	56⅝	22⅛	39⅛	985
6BD-230	P	4	6	3⅞ x 4½	52	2400	B	EL	..	..	38⅝	22¾	30¾	850
6BDM-230	M	4	6	3⅞ x 4½	50	2400	B	EL	..	S	56⅝	25⅛	31¾	1140
4BD-182	P	4	4	3¾ x 4½	39	2400	B	EL	..	..	30⅝	22¾	30¾	710
4BD-182	S	4	4	3¾ x 4½	32	1800	B	EL	..	..	50⅛	22⅛	39⅛	875
4BDM-182	M	4	4	3¾ x 4½	38	2400	B	EL	..	S	47⅛	25⅛	31¾	930
6BD-273	P	4	6	3¾ x 4½	65	2400	B	EL	..	..	38⅝	22¾	30¾	890
6BD-273	S	4	6	3¾ x 4½	50	1800	B	EL	..	..	56⅝	22⅛	39⅛	985
6BDM-273	M	4	6	3¾ x 4½	63	2400	B	EL	..	S	56⅝	25⅛	31¾	1250
6DT-317	S	4	6	3⅝ x 5½	56	1800	B	EL	..	..	64⅛	22⅛	47⅝	1650
6DT-317	P	4	6	3⅝ x 5½	79	2300	B	EL	..	..	41⅝	27½	40⅛	1150
6DTM-317	M	4	6	3⅝ x 5½	77	2300	B	EL	..	S	57⅞	29½	36¾	1795
6DT-468	S	4	6	4¼ x 5½	76	1600	B	EL	..	..	72⅝	29½	53⅝	2235
6DT-468	P	4	6	4¼ x 5½	96	2000	B	EL	..	..	48	26⅝	39⅛	1245
6DTM-468	M	4	6	4¼ x 5½	93	2000	B	EL	..	S	63⅞	32⅝	38	2140
6DTS-468	P	4	6	4¼ x 5½	135	2400	B	EL	M	..	47⅝	33⅛	41⅛	1565
6DAS-516	P	4	6	4⅞ x 5⅝	165	2400	B	EL	M	..	47½	34	47½	1625
6DA-779	P	4	6	5¼ x 6	165	1900	B	EL	..	..	58⅝	29⅝	49	2552
6DA-779	S	4	6	5¼ x 6	120	1400	B	EL	..	..	94¾	38	64	4505
6DA-844	P	4	6	5¼ x 6½	190	1950	B	EL	..	..	58⅝	29⅝	49	2630
6DA-844	S	4	6	5¼ x 6½	140	1400	B	EL	..	..	94¾	38	64	4605
6DAM-844	M	4	6	5¼ x 6½	184	1950	B	EL	..	S	77¾	30	46⅝	3700
6DAS-844	S	4	6	5¼ x 6½	155	1400	B	EL	M	..	94¾	38	64	2895
6DASM-844	M	4	6	5¼ x 6½	232	1950	B	EL	M	S	77¾	33⅝	46⅝	4100
6DAS-844	P	4	6	5¼ x 6½	245	1950	B	EL	M	..	58⅝	34⅝	48½	2674
8DA-1125	P	4	8	5¼ x 6½	250	1950	B	EL	..	..	75⅛	29⅝	50⅛	3400
8DA-1125	S	4	8	5¼ x 6½	171	1400	B	EL	..	..	110½	46	73⅛	5200
8DAM-1125	M	4	8	5¼ x 6½	242	1950	B	EL	..	S	96⅛	29⅝	46⅛	4500
8DAS-1125	P	4	8	5¼ x 6½	300	1950	B	EL	M	..	78	33⅝	50⅛	3580
8DAS-1125	S	4	8	5¼ x 6½	192	1400	B	EL	M	..	114	46	73⅛	5850
8DASM-1125	M	4	8	5¼ x 6½	290	1950	B	EL	M	S	100⅛	39⅛	45⅝	4900
4DC-645	S	4	6	5⅝ x 6½	97	1400	B	EL	..	..	78½	38	63⅞	3380
6DC-970	P	4	6	5⅝ x 6½	178	1800	B	EL	..	..	58⅝	29⅝	49	2600
6DC-970	S	4	6	5⅝ x 6½	140	1400	B	EL	..	..	94¾	38	64	4650
8DC-1290	S	4	8	5⅝ x 6½	190	1400	B	EL	..	..	110½	46	73	5250
8DC-1290	P	4	8	5⅝ x 6½	243	1800	B	EL	..	..	75⅛	29⅝	51	3450
6DC-1879	P	4	6	6¾ x 8¾	232	1200	B	A-EL	..	..	95½	53⅛	64½	6925
6DC-1879	S	4	6	6¾ x 8¾	171	900	B	A-EL	..	..	122	48	85⅛	8755
6DCM-1879	M	4	6	6¾ x 8¾	225	1200	B	A-EL	..	S	123½	40	64	8350
6DCS-1879	P	4	6	6¾ x 8¾	284	1200	B	A-EL	M	..	99⅝	53⅝	64½	7900
6DCSM-1879	M	4	6	6¾ x 8¾	275	1200	B	A-EL	M	S	125⅞	48	64	8700
8DCM-2505	M	4	8	6¾ x 8¾	325	1200	B	A-EL	..	W	133⅛	42	66¾	12400
8DC-2505	S	4	8	6¾ x 8¾	216	900	B	A-EL	..	..	148⅝	52	92	12840
8DCS-2505	S	4	8	6¾ x 8¾	320	900	B	A-EL	M	..	157½	63⅝	91¼	13240
8DCSM-2505	M	4	8	6¾ x 8¾	430	1200	B	A-EL	M	W	136⅛	50¾	66¾	13800

All engines have Lanova combustion system.

Caterpillar Tractor Co.
Peoria, Illinois

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
D397	S-P	4	V-12	5¼ x 8	500	1200	O	A-EL	M	..	107	54	93	11000
D397M	M	4	V-12	5¼ x 8	400	1200	O	A-EL	M	P	148	51	65	14200
D386	S-P	4	V-12	5¼ x 8	400	1200	O	A-EL	..	..	103	54	93	10770
D386M	M	4	V-12	5¼ x 8	320	1000-1200	O	A-EL	..	P	148	51	60	13200
D375	S-P	4	V-8	5¼ x 8	335	1200	O	A-EL	M	..	82	54	78	8550
D375M	M	4	V-8	5¼ x 8	270	1000-1200	O	A-EL	M	S	122	51	64	11350
D364	S-P	4	V-8	5¼ x 8	265	1200	O	A-EL	..	..	77	54	76	8370
D364M	M	4	V-8	5¼ x 8	215	1000-1200	O	A-EL	..	T-S	122	51	59	11170
D17000	S-P	4	V-8	5¼ x 8	200	1000	O	G-EL-A	..	..	85	51	51	8000
D17000M	M	4	V-8	5¼ x 8	150	1000	O	G-EL-A	..	T	120	50	93	9538
D13000	S-P	4	6	5¼ x 8	150	1000	O	G-EL-A	..	..	85	49	67	5610
D13000M	M	4	6	5¼ x 8	120	1000	O	G-EL-A	..	T-S	123	43	51	7050
D8800	S-P	4	4	5¼ x 8	102	1000	O	G-EL-A	..	..	66	48	67	4600
D8800M	M	4	4	5¼ x 8	82	1000	O	G-EL-A	..	T-S	95	47	49	5530
D337	S-P	4	6	5⅛ x 6	250	2000	O	G-EL-A	M	..	72	37	64	3950
D337M	M	4	6	5⅛ x 6	170	1600	O	G-EL-A	M	S	97	45	47	4650
D326	S-P	4	6	5⅛ x 6	170	2000	O	G-EL-A	..	..	72	43	52	3650
D326M	M	4	6	5⅛ x 6	118	1600	O	G-EL-A	..	S	98	45	47	4550
D318	S-P	4	6	4⅛ x 5½	103	1600	O	G-EL	..	..	77	31	57	3100
D318M	M	4	6	4⅛ x 5½	80	1600	O	G-EL	..	T-S	93	32	41	3620
D315	S-P	4	4	4⅛ x 5½	70	1600	O	G-EL	..	..	60	30	50	2450
D315M	M	4	4	4⅛ x 5½	53	1600	O	G-EL	..	T-S	75	31	40	2930
D311	S-P	4	4	4 x 5	52	1700	O	G-EL	..	..	58	28	52	1890
D311M	M	4	4	4 x 5	38	1600	O	G-EL	..	T	69	32	38	2500

Marine engine Hp. is for continuous 24-hr. duty. All other hp., max. without radiator fan. Dimensions and weights: Marine engines include reduction and reverse gear. Heights are above propeller shaft. All other engines w/o radiator fan. Weights are approximate. Widths include sump pump handle extended, starting crank, etc. All engines have "Caterpillar" fuel system—solid injection, precombustion chamber type. D397, D375 and D337 equipped with Roots blower. All engines available as "Caterpillar" Electric Sets.

Chicago Pneumatic Tool Co.
6 E. 44th Street
New York, N. Y.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
39CP	S	4	3	9 x 10½	142.5	720	BS	A	..	..	68	26	67	9590
49CP	S	4	4	9 x 10½	190	720	BS	A	..	..	72	31	67	10690
69CP	S	4	6	9 x 10½	285	720	BS	A	..	..	112	31	67	14240
89CP	S	4	8	9 x 10½	380	720	BS	A	..	..	140	33	67	17880
412CP	S	4	4	11 x 12	332	720	BS	A	..	..	106	47	95	21200
512CP	S	4	5	11 x 12	415	720	BS	A	..	..	124	55	95	25300
612CP	S	4	6	11 x 12	500	720	BS	A	..	..	143	55	95	31600
812CP	S	4	8	11 x 12	665	720	BS	A	..	..	178	68	95	35700
614CP	S	4	6	11 x 14¼	420	514	BS	A	..	..	143	55	95	32000
814CP	S	4	8	11 x 14¼	560	514	BS	A	..	..	178	68	95	36000
460CP	S	4	4	16 x 20	580	360	BS	A	..	..	171	85	125	62700
462CP	S	4	4	16 x 22	580	327	BS	A	..	..	171	85	125	62700
560CP	S	4	5	16 x 20	725	360	BS	A	..	..	197	85	125	70500
562CP	S	4	5	16 x 22	725	327	BS	A	..	..	197	85	125	70500
660CP	S	4	6	16 x 20	875	360	BS	A	..	..	223	85	125	78000
662CP	S	4	6	16 x 22	870	327	BS	A	..	..	223	85	125	78000
860CP	S	4	8	16 x 20	1160	360	BS	A	..	..	275	106	125	98700
862CP	S	4	8	16 x 22	1160	327	BS	A	..	..	275	106	125	98700
69CPS	S	4	6	9 x 10½	428	720	BS	A	TC	..	156	44	84	15740
89CPS	S	4	8	9 x 10½	570	720	BS	A	TC	..	184	58	84	19380
412CPS	S	4	4	11 x 12	500	720	BS	A	TC	..	128	47	113	23400
512CPS	S	4	5	11 x 12	620	720	BS	A	TC	..	146	55	113	27500
612CPS	S	4	6	11 x 12	750	720	BS	A	TC	..	164	55	113	31600
812CPS	S	4	8	11 x 12	1000	720	BS	A	TC	..	215	68	113	35790
614CPS	S	4	6	11 x 14¼	620	514	BS	A	TC	..	164	55	113	32000
814CPS	S	4	8	11 x 14¼	840	514	BS	A	TC	..	215	68	113	36000
460CPS	S	4	4	16 x 20	875	360	BS	A	TC	..	210	85	125	62700
462CPS	S	4	4	16 x 22	820	327	BS	A	TC	..	210	85	125	62700
560CPS	S	4	5	16 x 20	1060	360	BS	A	TC	..	236	106	125	70500
562CPS	S	4	5	16 x 22	1060	327	BS	A	TC	..	236	106	125	72700
660CPS	S	4	6	16 x 20	1310	360	BS	A	TC	..	262	106	125	78000
662CPS	S	4	6	16 x 22	1310	327	BS	A	TC	..	262	106	125	80300
860CPS	S	4	8	16 x 20	1750	360	BS	A	TC	..	320	116	125	98700
862CPS	S	4	8	16 x 22	1750	327	BS	A	TC	..	320	116	125	101200

Engines have open-combustion chamber. Stationary use. All engines can be furnished as dual-fuel units.

Clark Bros. Co., Inc.
Olean, New York

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
RAD2	S	2	2	14 x 14	200	330	B-BS	A	..	..	..	..	..	28700
RAD32	S	2	3	14 x 14	300	330	B-BS	A	..	..	..	..	..	33850
RAD4	S	2	4	14 x 14	400	330	B-BS	A	..	..	..	..	..	42700
RAD5	S	2	5	14 x 14	500	330	B-BS	A	..	..	..	..	..	52700
RAD6	S	2	6	14 x 14	600	330	B-BS	A	..	..	..	..	..	65550
RAD8	S	2	8	14 x 14	800	330	B-BS	A	..	..	..	..	..	70400
DG4	S	2	4	12½ x 16	380- 500	300- 400	B-BS	A	..	..	..	..	..	.....
DG5	S	2	5	12½ x 16	475- 675	300- 400	B-BS	A	..	..	..	..	..	.....
DG6	S	2	6	12½ x 16	570- 750	300- 400	B-BS	A	..	..	..	..	..	.....
DG8	S	2	8	12½ x 16	760-1000	300- 400	B-BS	A	..	..	..	..	..	.....
MD4	M	2	4	12½ x 16	400	315	B-BS	A	..	..	..	..	..	42000
MD6	M	2	6	12½ x 16	600	315	B-BS	A	..	..	..	..	..	56000

All engines have open type combustion chambers.

Climax Engine & Pump Mfg. Co.
Clinton, Iowa

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
D-148	S	4	2	4¼ x 5¼	18	1200	B	EL	..	..	32	26	44	1950
D-297	S	4	4	4¼ x 5¼	36	1200	B	EL	..	..	47	26	44	2950

Stationary use.

Continental Motors Corp.
Muskegon, Mich.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
GD-157	S	4	4	3⅜ x 4⅜	39	2000	B	EL	..	..	31⅝	15¼	30¼	605
HD-260	S	4	4	3⅞ x 5½	59.3	2000	B	EL	..	..	33⅝	21⅝	35	840
TD-427	S	4	6	4⅛ x 4⅞	106.5	2000	B	EL	..	..	47⅛	21⅝	37⅛	1300
RD-572	S	4	6	4¾ x 5⅜	142.5	2000	B	EL	..	..	51¹⁵⁄₁₆	28	44⅝	1845
TD-642J	P	4	6	4⅛ x 4⅞	116	2400	B	EL	..	..	46¾	20½	36⅝	1270
RD-657½	P	4	6	4¾ x 5⅜	162	2400	B	EL	..	..	52⅛	20½	41⅛	1785
SD-6802	P	4	6	5⅜ x 5½	217	2200	B	EL	..	..	..	..	..	..

Models designated for portable use are transportation engines. All others are industrial or agricultural except HD-260 which is industrial only. Ratings given are bare engine hp.

Cooper-Bessemer Corp.
Mount Vernon, Ohio

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
FW6	S	4	6	9 x 10½	430	1000	BS	A	..	..	130	34⅜	80	17800
FW6T	S	4	6	9 x 10½	835	1000	BS	A	TC	..	176	34¾	80	18300
FV8	S	4	8	9 x 10½	575	1000	BS	A	..	..	102	43⅛	57⅜	22000
FV8T	S	4	8	9 x 10½	1110	1000	BS	A	TC	..	124	43⅛	57¾	27240
FV12	S	4	12	9 x 10½	860	1000	BS	A	..	..	140	43⅛	57¾	26000
FV12T	S	4	12	9 x 10½	1670	1000	BS	A	TC	..	140	43⅛	57¾	37880
FV16	S	4	16	9 x 10½	1150	1000	BS	A	..	..	165	43⅛	57⅜	32000
FV16T	S	4	16	9 x 10½	2230	1000	BS	A	TC	..	165	43⅛	57⅜	46430
GS6	S	4	6	10⅜ x 13½	565	750	O	A	..	..	142½	37½	67¾	21500
GS6T	S	4	6	10⅜ x 13½	1090	750	O	A	TC	..	174	37½	67¾	22250
GS8	S	4	8	10⅜ x 13½	755	750	O	A	..	..	175	37½	67¾	29500
GS8T	S	4	8	10⅜ x 13½	1460	750	O	A	TC	..	206½	37½	67¾	30250
JS5	S	4	5	13 x 16	515	450	O	A	..	..	149	44¼	79⅝	41000
JS6	S	4	6	13 x 16	705	514	O	A	..	..	171	44¼	79⅝	44000
JS6T	S	4	6	13 x 16	1360	514	O	A	TC	..	199½	44¼	79⅝	45500
JS7	S	4	7	13 x 16	820	514	O	A	..	..	193	44¼	79⅝	48000
JS7T	S	4	7	13 x 16	1585	514	O	A	TC	..	221	44¼	79⅝	49000
JS8	S	4	8	13 x 16	935	514	O	A	..	..	210	44¼	79⅝	51000
JS8T	S	4	8	13 x 16	1815	514	O	A	TC	..	238½	44¼	79⅝	52000
LS6	S	4	6	15½ x 22	965	360	O	A	..	..	224	55⅝	120	76000
LS6T	S	4	6	15½ x 22	1870	360	O	A	TC	..	251	55⅝	120	77000
LS7	S	4	7	15½ x 22	1125	360	O	A	..	..	248	55⅝	120	91000
LS7T	S	4	7	15½ x 22	2180	360	O	A	TC	..	270	55⅝	120	92000
LS8	S	4	8	15½ x 22	1285	360	O	A	..	..	276	55⅝	120	106000
LS8T	S	4	8	15½ x 22	2500	360	O	A	TC	..	299	55⅝	120	107000
LSV12	S	4	12	15½ x 22	1925	360	O	A	..	..	252	68	117	194500
LSV12T	S	4	12	15½ x 22	3740	360	O	A	TC	..	300	68	117	197500
LSV16	S	4	16	15½ x 22	2565	360	O	A	..	..	307	68	117	232500
LSV16T	S	4	16	15½ x 22	5000	360	O	A	TC	..	355	68	117	237500
FW6MG	M	4	6	9 x 10½	430	1000	BS	A	..	O	171	43⅛	57⅜	19500
FW6MGT	M	4	6	9 x 10½	835	1000	BS	A	TC	O	171	43⅛	57⅜	20000
FV8MG	M	4	8	9 x 10½	575	1000	BS	A	..	O	186	43⅛	57⅜	23000
FV8MGT	M	4	8	9 x 10½	1110	1000	BS	A	TC	O	186	43⅛	57⅜	23000
FV12MG	M	4	12	9 x 10½	860	1000	BS	A	..	O	220	43⅛	57⅜	29300
FV12MGT	M	4	12	9 x 10½	1670	1000	BS	A	TC	O	255	43⅛	57⅜	30000
FV16MG	M	4	16	9 x 10½	1150	1000	BS	A	..	O	262	43⅛	57⅜	35500
FV16MGT	M	4	16	9 x 10½	2230	1000	BS	A	TC	O	303	43⅛	57⅜	36500
GS6DR	M	4	6	10⅜ x 13½	565	750	O	A	..	D	175	37½	67¾	34000
GS6DRT	M	4	6	10⅜ x 13½	1090	750	O	A	TC	D	178	37½	67¾	36000
GS8DR	M	4	8	10⅜ x 13½	755	750	O	A	..	D	208	37½	67¾	42000
GS8DRT	M	4	8	10⅜ x 13½	1460	750	O	A	TC	D	210	37½	67¾	44000
JS6DR	M	4	6	13 x 16	705	514	O	A	..	D	177	44¼	79⅝	46000
JS6DRT	M	4	6	13 x 16	1360	514	O	A	TC	D	177	44¼	79⅝	50000
JS8DR	M	4	8	13 x 16	935	514	O	A	..	D	216	44¼	79⅝	55000
JS8DRT	M	4	8	13 x 16	1815	514	O	A	TC	D	216	44¼	79⅝	60000
LS6DR	M	4	6	15½ x 22	965	360	O	A	..	D	239	55⅝	120	90000
LS6DRT	M	4	6	15½ x 22	1870	360	O	A	TC	D	239	55⅝	120	91000
LS8DR	M	4	8	15½ x 22	1285	360	O	A	..	D	287	55⅝	120	110000
LS8DRT	M	4	8	15½ x 22	2500	360	O	A	TC	D	287	55⅝	120	111000
LSV12DR	M	4	12	15½ x 22	1925	360	O	A	..	D	243	68	117	190000
LSV12DRT	M	4	12	15½ x 22	3740	360	O	A	TC	D	263	68	117	191000
LSV16DR	M	4	16	15½ x 22	2565	360	O	A	..	D	298	68	117	217000
LSV16DRT	M	4	16	15½ x 22	5000	360	O	A	TC	D	341	68	117	219000

Engines have open combustion chamber. Models marked M for marine use only; all others can be furnished for either straight diesel or dual-fuel operation. All stationary models FV, FW are available also as gas engines and gas-diesels. Width is between bolt centers. Height is given above shaft.

Cummins Engine Company, Inc.
Columbus, Indiana

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. H.P.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
A-600	M-S-P	4	6	4 x 5	100	2200	O	EL	..	T	48	27	37	1440†
HR400	M-S-P	4	4	5½ x 6	110	1800	O	EL	..	T	42	30	47	1640†
JBS-600	P	4	6	4½ x 5	150	2500	O	EL	M	..	47	25	40	1545†
H600	M-S-P	4	6	4⅞ x 6	150	1800	O	EL	..	T	57	30	46	2395†
HR600	M-S-P	4	6	5½ x 6	165	1800	O	EL	..	T	57	30	46	2400†
HRBB-600	P	4	6	5½ x 6	175	2000	O	EL	..	..	61	30	49	2450†
HS600	S-P	4	6	4⅞ x 6	200	1800	O	EL	M	T	58	32	47	2580†
NH600	M-S-P	4	6	5½ x 6	200	2100	O	EL	..	T	59	41	63	2480†
NHH600	P	4	6	5½ x 6	200	2100	O	EL	..	..	64	55	23	2285†
HRS600	M-S-P	4	6	5½ x 6	225	1800	O	EL	M	T	58	32	47	2580†
NHS600	M-S-P	4	6	5½ x 6	275	2100	O	EL	M	C	59	41	61	2775
NHRS600	M-S-P	4	6	5½ x 6	300	2100	O	EL	M	C	59	41	61	2725†
NHHS600	P	4	6	5½ x 6	275	2100	O	EL	M	..	64	55	23	2580†
NVH1200	M-S-P	4	12	5½ x 6	400	2100	O	EL	..	S	73	41	55	4300†
NVHS1200	M-S-P	4	12	5½ x 6	550	2100	O	EL	M	S	73	42	55	4550†
VT-12	M-S-P	4	12	5¾ x 6	600	2100	O	EL	TC	C	83½	44½	60	6120*
L600	M-S	4	6	7 x 10	250	1000	O	A-EL	..	C	92	44	58	7590*
LR600	M-S	4	6	7¼ x 10	300	1100	O	A-EL	..	C	92	44	58	7590*

*All engines have exclusive Cummins fuel system. All except, L-600 and LR-600 suitable for automotive and other portable applications. † Automotive weight with all accessory equipment; also approx. weight of stationary engine w/o radiator or clutch; and approx. weight of marine engine w/o reverse gear. * Stationary engine and approx. marine weight w/o reverse gear. Hp. ratings and rpm. are maximum ratings.*

Enterprise Engine & Machinery Co.
Subsidiary of General Metals Corp.
18th & Florida Streets, San Francisco, Calif.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
DM3	M-S	4	3	8 x 10	73- 162	450-1000	BS	A-EL	..	RR	54¾†- 91⅝*	42½††	71¾†	6500†- 8000*
DM4	M-S	4	4	8 x 10	97- 216	450-1000	BS	A-EL	..	RR	66¾†-107⅝*	42½††	71¾†	7520†- 9500*
DM6	M-S	4	6	8 x 10	146- 324	450-1000	BS	A-EL	..	RR	90¾†-131⅝*	42½††	71¾†	9000†-12000*
DM36	M-S	4	6	8 x 10	274- 609	450-1000	BS	A-EL	TC	RR	90¾†-131⅝*	42½††	71¾†	10000†-12500*
DG6	M-S	4	6	12 x 15	273- 655	250- 600	BS	A	..	RR	148½†-189¾*	46¼†	95⅛†	32000†-34500*
DG36	M-S	4	6	12 x 15	482-1157	250- 600	BS	A	TC	RR	148½†-189¾*	46¼†	95⅛†	33500†-36000*
DG8	M-S	4	8	12 x 15	364- 874	250- 600	BS	A	..	RR	182½†-223¾*	46¼†	95⅛†	42800†-45000*
DG38	M-S	4	8	12 x 15	643-1542	250- 600	BS	A	TC	RR	182½†-223¾*	46¼†	95⅛†	44500†-47000*
DQ6	M-S	4	6	16 x 20	647- 971	250- 375	BS	A	..	RR	192½†-250*	60†	124†	77000†- 79000*
DQ36	M-S	4	6	16 x 20	1142-1713	250- 375	BS	A	TC	RR	192½†-250*	60†	124†	79000†- 81000*
DQ8	M-S	4	8	16 x 20	863-1294	250- 375	BS	A	..	RR	240½†-306*	60†	124†	91000†- 94000*
DQ38	M-S	4	8	16 x 20	1523-2284	250- 375	BS	A	TC	RR	240½†-306*	60†	124†	94000†- 97000*

*Engines have open combustion chamber. †Stationary M series shown with standard flywheel and thrust bearing, G and Q series without flywheel. *Marine M series shown with standard flywheel and RR gear. G and Q series are shown with standard flywheel and thrust bearing. On M series add 4½ in for marine width and subtract 4 in for marine height. RR—Reverse and reduction gear—make varies.*

Fairbanks, Morse & Company
600 S. Michigan Avenue
Chicago, Ill.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
31A6¼	M	2	5	6¼ x 9	150	720	O	A	..	D	..	..	..	..
31A6¼	M	2	6	6¼ x 9	180	720	O	A	..	D	..	..	..	..
31A6¼	M	2	7	6¼ x 9	210	720	O	A	..	D	..	..	..	..
31A6¼	M	2	8	6¼ x 9	240	720	O	A	..	D	..	..	..	..
31A6¼	S-P	2	5	6¼ x 9	150-175	720	O	A	..	..	..	..	..	..
31A6¼	S-P	2	6	6¼ x 9	180-210	720	O	A	..	..	..	..	..	..
31A6¼	S-P	2	7	6¼ x 9	210-245	720	O	A	..	..	..	..	..	..
31A6¼	S-P	2	8	6¼ x 9	240-280	720	O	A	..	..	..	..	..	..
31A8½	S-P	2	5	8½ x 11½	300-325	514	O	A	..	..	..	..	..	..
31A8½	S-P	2	6	8½ x 11½	360-390	514	O	A	..	..	..	..	..	..
31A8½	S-P	2	7	8½ x 11½	420-455	514	O	A	..	..	..	..	..	..
31A8½	S-P	2	8	8½ x 11½	480-520	514	O	A	..	..	..	..	..	..
31A8½	M	2	5	8½ x 11½	275	525	O	A	..	D	..	..	..	..
31A8½	M	2	6	8½ x 11½	330	525	O	A	..	D	..	..	..	..
31A8½	M	2	7	8½ x 11½	385	525	O	A	..	D	..	..	..	..
31A8½	M	2	8	8½ x 11½	440	525	O	A	..	D	..	..	..	..
31A18	S	2	6	18 x 27	2100	277	O	A	..	..	..	..	..	..
31A18	S	2	8	18 x 27	2800	277	O	A	..	..	..	..	..	..
31A18	S	2	10	18 x 27	3500	277	O	A	..	..	..	..	..	..
32E12	S	2	2	12 x 15	120	360	O	A	..	..	..	..	..	..
32E12	S	2	3	12 x 15	180	360	O	A	..	..	..	..	..	..
32E14	S	2	2	14 x 17	150	300	O	A	..	..	..	..	..	..
32E14	S	2	3	14 x 17	225	300	O	A	..	..	..	..	..	..
32E14	S	2	4	14 x 17	300	300	O	A	..	..	..	..	..	..
32E14	S	2	5	14 x 17	375	300	O	A	..	..	..	..	..	..
32E14	S	2	6	14 x 17	450	300	O	A	..	..	..	..	..	..
33F12	S	2	5	12 x 15	500	400	O	A	..	..	..	..	..	..
33F12	S	2	6	12 x 15	600	400	O	A	..	..	..	..	..	..
33E14	S	2	5	14 x 17	575	300	O	A	..	..	..	..	..	..
33E14	S	2	6	14 x 17	690	300	O	A	..	..	..	..	..	..
33E14	S	2	7	14 x 17	805	300	O	A	..	..	..	..	..	..
33F16	S	2	4	16 x 20	800	300	O	A	..	..	..	..	..	..
33F16	S	2	5	16 x 20	1000	300	O	A	..	..	..	..	..	..
33F16	S	2	6	16 x 20	1200	300	O	A	..	..	..	..	..	..
33F16	S	2	7	16 x 20	1400	300	O	A	..	..	..	..	..	..
33F16	S	2	8	16 x 20	1600	300	O	A	..	..	..	..	..	..
33F16	S	2	10	16 x 20	2000	300	O	A	..	..	..	..	..	..
37F12	M	2	5	12 x 15	500	400	O	A	..	D	..	..	..	..
37F12	M	2	6	12 x 15	600	400	O	A	..	D	..	..	..	..
37E14	M	2	5	14 x 17	575	300	O	A	..	D	..	..	..	..
37E14	M	2	6	14 x 17	690	300	O	A	..	D	..	..	..	..
37E14	M	2	7	14 x 17	805	300	O	A	..	D	..	..	..	..
37F16	M	2	5	16 x 20	1000	300	O	A	..	D	..	..	..	..
37F16	M	2	6	16 x 20	1200	300	O	A	..	D	..	..	..	..
37F16	M	2	7	16 x 20	1400	300	O	A	..	D	..	..	..	..
37F16	M	2	8	16 x 20	1600	300	O	A	..	D	..	..	..	..
37F16	M	2	10	16 x 20	2125	300	O	A	..	D	..	..	..	..
38F5¼	M	2	4	5¼ x 7¼	300	1200	B	A-EL	..	S	..	..	..	..
38F5¼	M	2	5	5¼ x 7¼	375	1200	B	A-EL	..	S	..	..	..	..
38F5¼	M	2	6	5¼ x 7¼	450	1200	B	A-EL	..	S	..	..	..	..
38F5¼	M	2	7	5¼ x 7¼	525	1200	B	A-EL	..	S	..	..	..	..
38F5¼	M	2	8	5¼ x 7¼	600	1200	B	A-EL	..	S	..	..	..	..
38F5¼	M	2	10	5¼ x 7¼	750	1200	B	A-EL	..	F	..	..	..	..
38F5¼	S-P	2	4	5¼ x 7¼	300- 330*	1200	B	A-EL	..	..	..	..	..	..
38F5¼	S-P	2	5	5¼ x 7¼	395- 413*	1200	B	A-EL	..	..	..	..	..	..
38F5¼	S-P	2	6	5¼ x 7¼	450- 495*	1200	B	A-EL	..	..	..	..	..	..
38F5¼	S-P	2	7	5¼ x 7¼	525- 578*	1200	B	A-EL	..	..	..	..	..	..
38F5¼	S-P	2	8	5¼ x 7¼	600- 660*	1200	B	A-EL	..	..	..	..	..	..
38F5¼	S-P	2	10	5¼ x 7¼	750- 825*	1200	B	A-EL	..	..	..	..	..	..
38D8⅛	M	2	4	8⅛ x 10	640	720	O	A	..	D	..	..	..	..
38D8⅛	M	2	5	8⅛ x 10	800	720	O	A	..	D	..	..	..	..
38D8⅛	M	2	6	8⅛ x 10	960	720	O	A	..	D	..	..	..	..
38D8⅛	M	2	8	8⅛ x 10	1280	720	O	A	..	D	..	..	..	..
38D8⅛	M	2	10	8⅛ x 10	1600	720	O	A	..	D	..	..	..	..
38D8⅛	M	2	12	8⅛ x 10	1920	720	O	A	..	D	..	..	..	..
38D8⅛	S	2	4	8⅛ x 10	400- 800*	450- 900	O	A	..	..	..	..	..	..
38D8⅛	S	2	5	8⅛ x 10	500-1000*	450- 900	O	A	..	..	..	..	..	..
38D8⅛	S	2	6	8⅛ x 10	600-1200*	450- 900	O	A	..	..	..	..	..	..
38D8⅛	S	2	8	8⅛ x 10	800-1600*	450- 900	O	A	..	..	..	..	..	..
38D8⅛	S	2	10	8⅛ x 10	1000-2000*	450- 900	O	A	..	..	..	..	..	..
38D8⅛	S	2	12	8⅛ x 10	1200-2400*	450- 900	O	A	..	..	..	..	..	..
45B3⅛	S	4	1	3⅛ x 4	5¼	1800	D-M	H-EL	..	..	..	..	..	..
45B4⅛	S	4	1	4⅛ x 4½	10½	1800	D-M	H-EL	..	..	..	..	..	..
48A3	M	4	1	3 x 4	3½	1800	O	EL	..	S-T	..	..	..	..
48A3	S	4	1	3 x 4	3½	1800	O	EL	..	S-T	..	..	..	..
48A3½	M	4	2	3½ x 4	13½	1800	O	EL	..	S-T	..	..	..	..
48A3½	S	4	2	3½ x 4	13½	1800	O	EL	..	S-T	..	..	..	..
48A4	M	4	2	4 x 5	16- 20	1200-1800	O	H-EL	..	S-T	..	..	..	..
48A4	M	4	3	4 x 5	25- 30	1200-1800	O	H-EL	..	S-T	..	..	..	..
48A4	M	4	6	4 x 5	50- 61	1200-1800	O	EL	..	S-T	..	..	..	..
48A4	S-P	4	1	4 x 5	8- 10	1200-1800	O	EL	..	S-T	..	..	..	..
48A4	S-P	4	2	4 x 5	16- 20	1200-1800	O	EL	..	S-T	..	..	..	..
48A4	S-P	4	3	4 x 5	25- 30	1200-1800	O	EL	..	S-T	..	..	..	..

(Fairbanks-Morse Specifications continued on next page)

Fairbanks, Morse & Company

(Continued from preceding page)

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Heigth In.	Weigh Lb.
48A4	S-P	4	6	4 x 5	50–61	1200–1800	O	EL	..	S-T	..	..	..	..
48A4¼	M	4	2	4¼ x 5	22	1200–1800	O	H-EL	..	S-T	..	..	..	..
48A4¼	M	4	3	4¼ x 5	34	1200–1800	O	H-EL	..	S-T	..	..	..	..
48A4¼	M	4	6	4¼ x 5	67	1200–1800	O	EL	..	S-T	..	..	..	..
48A4¼	S-P	4	1	4¼ x 5	9–11	1200–1800	O	EL	..	S-T	..	..	..	..
48A4¼	S-P	4	2	4¼ x 5	18–22	1200–1800	O	EL	..	S-T	..	..	..	..
48A4¼	S-P	4	3	4¼ x 5	28–34	1200–1800	O	EL	..	S-T	..	..	..	..
48A4¼	S-P	4	6	4¼ x 5	56–67	1200–1800	O	EL	..	S-T	..	..	..	..
49A4½	M	2	1	4½ x 5½	20	1200	B-BS	EL	..	S-T	..	..	..	..
49A4½	M	2	2	4½ x 5½	40	1200	B-BS	EL	..	S-T	..	..	..	..
49A4½	M	2	3	4½ x 5½	60	1200	B-BS	EL	..	S-T	..	..	..	..
49A4½	M	2	4	4½ x 5½	80	1200	B-BS	EL	..	S-T	..	..	..	..
49A4½	M	2	6	4½ x 5½	120	1200	B-BS	EL	..	S-T	..	..	..	..
49A4½	S-P	2	1	4½ x 5½	20	1200	B-BS	EL	..	S-T	..	..	..	..
49A4½	S-P	2	2	4½ x 5½	40	1200	B-BS	EL	..	S-T	..	..	..	..
49A4½	S-P	2	3	4½ x 5½	60	1200	B-BS	EL	..	S-T	..	..	..	..
49A4½	S-P	2	4	4½ x 5½	80	1200	B-BS	EL	..	S-T	..	..	..	..
49A4½	S-P	2	6	4½ x 5½	120	1200	B-BS	EL	..	S-T	..	..	..	..

Fulton Iron Works Company
St. Louis, Missouri

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
BGS	S	4	5	17½ x 24½	765	257	O	A	..	..	..	..	..	104000
BGS	S	4	5	17½ x 24½	825	277	O	A	..	..	..	..	..	104000
BGSS	S	4	5	17½ x 24½	1145	257	O	A	TC	..	..	..	..	106000
BGSS	S	4	5	17½ x 24½	1235	277	O	A	TC	..	..	..	..	106000
BGS	S	4	6	17½ x 24½	915	257	O	A	..	..	..	..	..	121280
BGS	S	4	6	17½ x 24½	990	277	O	A	..	..	..	..	..	121280
BGSS	S	4	6	17½ x 24½	1375	257	O	A	TC	..	..	..	..	123300
BGSS	S	4	6	17½ x 24¼	1480	277	O	A	TC	..	..	..	..	123300
BGS	S	4	7	17½ x 24½	1070	257	O	A	..	..	..	..	..	138650
BGS	S	4	7	17½ x 24½	1155	277	O	A	..	..	..	..	..	138650
BGSS	S	4	7	17½ x 24½	1600	257	O	A	TC	..	..	..	..	141500
BGSS	S	4	7	17½ x 24½	1730	277	O	A	TC	..	..	..	..	141500
BGS	S	4	8	17½ x 24½	1220	257	O	A	..	..	..	..	..	159930
BGS	S	4	8	17½ x 24½	1320	277	O	A	..	..	..	..	..	156930
BGSS	S	4	8	17½ x 24½	1830	257	O	A	TC	..	..	..	..	160000
BGSS	S	4	8	17½ x 24½	1980	277	O	A	TC	..	..	..	..	160000
KS	S	4	6	24 x 28	1725	225	O	A	..	..	..	..	..	220000
KS	S	4	6	24 x 28	1970	257	O	A	..	..	..	..	..	220000
KS	S	4	6	24 x 28	2590	225	O	A	TC	..	..	..	..	222000
KS	S	4	6	24 x 28	2960	257	O	A	TC	..	..	..	..	222000
KSS	S	4	8	24 x 28	2300	225	O	A	..	..	..	..	..	280000
KSS	S	4	8	24 x 28	2630	257	O	A	..	..	..	..	..	280000
KSS	S	4	8	24 x 28	3455	225	O	A	TC	..	..	..	..	282000
KSS	S	4	8	24 x 28	3945	257	O	A	TC	..	..	..	..	282000

Normally aspirated engines are designated BGS and KS types. Supercharged engines are designated BGSS and KSS types. Dual-fuel normally aspirated engines are designated BGSD and KSD types. Dual-fuel supercharged engines are designated BGSSD and KSSD types.

General Motors Corporation
Cleveland Diesel Engine Division
Cleveland, Ohio

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. H.P.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
3-268A*	S-M	2	3	6½ x 7	(100kw*)	1200	O	EL	..	..	104	39¾	64¾	8050*
4-268A†	S-M	2	4	6½ x 7	250	1300	O	EL-A	..	..	132	39	64⅞	10160†
4-268A*	S-M	2	4	6½ x 7	(150 kw*)	1200	O	EL	..	..	120	39¾	64¾	10500*
6-268A†	S-M	2	6	6½ x 7	375	1300	O	EL-A	..	..	156	39	63⅞	11300†
6-268A*	S-M	2	6	6½ x 7	(200 kw*)	1200	O	EL	..	..	152	42	74	14470*
8-268A†	S-M	2	8	6½ x 7	500	1300	O	EL-A	..	..	181⅛	41	66	14050†
8-268A*	S-M	2	8	6½ x 7	(300 kw*)	1200	O	EL	..	..	174	46	74	17020*
6-278A†	S-M	2	6	8¾ x 10½	615	750	O	EL-A	..	..	172¾	63¾	88¾	25700†
6-278A*	S-M	2	6	8¾ x 10½	(400 kw*)	750	O	EL	..	..	159	53	97¾	27400*
8-278A†	S-M	2	8	8¾ x 10½	820	750	O	EL-A	..	..	193	63¾	91	30200†
8-278A*	S-M	2	8	8¾ x 10½	(500 kw*)	750	O	EL	..	..	183	53	97¾	32600*
12-278A†	S-M	2	12	8¾ x 10½	1230	750	O	EL-A	..	..	258	63⅝	101¾	42100†
12-278A*	S-M	2	12	8¾ x 10½	(750 kw*)	750	O	EL	..	..	224	60	107¾	42000*
16-278A†	S-M	2	16	8¾ x 10½	1640	750	O	EL-A	..	..	312	69	106⅝	56800†
16-278A*	S-M	2	16	8¾ x 10½	(1000 kw*)	750	O	EL	..	..	279	77	107¾	52300*

**Entries so marked refer to models supplied as D.C. generating sets, in which cases ratings under column "Cont. H.P." is given in kilowatts and weights are for entire generating set assembly.*

†*Entries so marked refer to models supplied as propulsion engines, in which cases weights include reverse and reduction gearings. Heights—above shaft ctr.*

General Motors Corporation
Detroit Diesel Engine Division
Detroit, Michigan

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
2-71	M*	2	2	4¼ x 5	62	2000	O	EL	M**	S	51	30	36	1300
2-71	M†	2	2	4¼ x 5	43	1600	O	EL	M**	S	51	30	37	1300
2-71	S-P	2	2	4¼ x 5	42	1600	O	EL	M**	..	31	27⅝	35⅜	960
3-71	M*	2	3	4¼ x 5	101	2100	O	EL	M**	O	56⅛	32½	40¼	2020
3-71	M†	2	3	4¼ x 5	61	1600	O	EL	M**	O	56⅛	32½	40¼	2110
3-71	S-P	2	3	4¼ x 5	62	1600	O	EL	M**	..	37⅜	29½	39⅝	1480
4-71	M*	2	4	4¼ x 5	138	2100	O	EL	M**	O	62	33¼	40¼	2410
4-71	M†	2	4	4¼ x 5	85	1600	O	EL	M**	O	64	33¼	40¼	2500
4-71	S-P	2	4	4¼ x 5	86	1600	O	EL	M**	..	42⅜	29½	40⅝	1720
6-71	M*	2	6	4¼ x 5	216	2100	O	EL	M**	O	73⅝	32½	40¼	2645
6-71	M†	2	6	4¼ x 5	133	1600	O	EL	M**	O	73⅝	33½	40¼	2720
6-71	S-P	2	6	4¼ x 5	131	1600	O	EL	M**	..	54⅛	29½	41¼	2100
Twin 4	S-P	2	8	4¼ x 5	167	1600	O	EL	M**	..	68¾	56	58	4700
Twin 6-71	M*	2	12	4¼ x 5	432	2100	O	EL	M**	O	79½	56	56⅜	6400
Twin 6-71	M†	2	12	4¼ x 5	266	1600	O	EL	M**	O	79½	56	56⅜	6400

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
Twin 6-71	S-P	2	12	4¼ x 5	256	1600	O	EL	M**	..	79¾	56	58	4700
Tandam Twin 6-71	M*	2	12	4¼ x 5	432	2100	O	EL	M**	O	129	37¼	57	7550
Tandem Twin 6-71	M†	2	12	4¼ x 5	266	1600	O	EL	M**	O	129	37¼	57	7550
Quad 6	M*	2	24	4¼ x 5	864	2100	O	EL	M**	O	128	56	54⅛	12600
Quad 6	M†	2	24	4¼ x 5	531	1600	O	EL	M**	O	128	56	54⅛	12600
Quad 6	S-P	2	24	4¼ x 5	512	1600	O	EL	M**	..	174	56⅛	68⅝	12065
6-110	M*	2	6	5 x 5.6	265	1800	O	EL	M**	O	79¼	31	47⅜	4300
6-110	M†	2	6	5 x 5.6	205	1600	O	EL	M**	O	79¼	31	47⅜	4300
6-110	S-P	2	6	5 x 5.6	512	1600	O	EL	M**	..	69¼	31¾	49	2960
4-51	M*	2	4	4.1 x 4.1	87	3000	O	EL	M**	P	49¼	22	31	1500
4-51	M†	2	4	4.1 x 4.1	54	2200	O	EL	M**	P	49¼	22	31	1500

** Pleasure craft: Rated SHP. † Work boat: Continuous ship. ** Pressure scavenging. Weights and dimensions of marine engines vary with gear selected. Industrial engines available with torque converters.*

General Motors Corporation
Electro-Motive Division
La Grange, Ill.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
6-567A	P	2	6	8½ x 10	600	800	O	EL	..	..	115⅝	64⅞	84⅛	15000
8-567B	P	2	8	8½ x 10	800	800	O	EL	..	..	139⅛	62⅝	92	17500
12-567B	P	2	12	8½ x 10	1200	800	O	EL	..	..	174½	64⅞	90	23500
12-567B	P	2	12	8½ x 10	1125	800	O	EL	..	..	174½	64⅞	90	23500
16-567B	P	2	16	8½ x 10	1500	800	O	EL	..	..	212⅛	62⅝	88	30000

Engines are available for marine and industrial use through Cleveland Diesel Engine Division, G.M.C. All engines have open type combustion chambers.

Gray Marine Motor Company
687 Canton Avenue
Detroit 7, Michigan

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
D-157	M	4	4	3⅛ x 4⅛	30	1800	B	EL	..	T	47	22	26*	1100
D-260	M	4	4	3⅞ x 5½	50	1800	B	EL	..	T	52	22	31½*	1400
D-427	M	4	6	4⅝ x 4¾	100	2200	B	EL	..	P	69	29	27*	1600
D-572	M	4	6	4¾ x 5⅜	135	2200	B	EL	..	T	78	27	28¾*	2700

*Engines have dyna-cell combustion systems. Marine use only. Horsepower ratings are maximum. *Height above prop. shafts center line.*

Hallett Manufacturing Co.
1601 W. Florence Ave.
Inglewood, Calif.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
AC1	S	4	1	3½ x 3½	5.5	1800	B	H-EL*	..	..	26⅝	15	24	220
AC2	S	4	2	3½ x 3¾	13	1800	B	H-EL*	..	..	26	25	25	350
D-1A	S	4	1	3⅝ x 4¼	8	1500	B	H-EL*	..	..	24	20	30	450
D-2S	S	4	2	3⅝ x 4¼	18	1500	B	EL	..	..	31⅝	23	31⅛	566
D-1M	M	4	1	3⅝ x 4¼	8	1500	B	H-EL*	..	S	37½	23	30	630
D-2MS	M	4	2	3⅝ x 4¼	18	1500	B	EL	..	S	49	23	31⅛	760
WC2M	M	4	2	3½ x 3¾	12	1800	B	EL	..	S	33	25½	25	485

*Engines have open combustion chamber. * Model designation refers to hand starting. "S" is added to designation to indicate electric starting.*

P&H Diesel Engine Division
Harnischfeger Corporation
500 South Main Street
Crystal Lake, Illinois

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
187C	M-P	2	1	4½ x 5½	22	1400	BS-B-DM	EL	M	S-T-W	25⅝	28¼	40⅛	845-1180*
287C	M-P	2	2	4½ x 5½	44	1400	BS-B-DM	EL	M	S-T-W	32⅛	28¼	40⅛	1030-1550*
387C	M-P	2	3	4½ x 5½	66	1400	BS-B-DM	EL	M	S-T-W	38⅞	28¼	40⅛	1350-1775*
487C	M-P	2	4	4½ x 5½	88	1400	BS-B-DM	EL	M	S-T-W	45⅝	28¼	40⅛	1530-2600*
687C	M-P	2	6	4½ x 5½	132	1400	BS-B-DM	EL	M	S-T-W	59⅛	28¼	40⅛	1900-2950*

**Weights shown are approximate for complete marine units including all accessories.*

Hercules Motors Corp.
Canton, Ohio

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
DIX2D-83	M-S-P	4	2	3⅝ x 4	24½	2200	B	EL-H	..	..	21½	22	30½	400
DIXC	M-S-P	4	2	4 x 4½	27.6	1800	B	EL	..	..	22	20	21	550
DIXD	M-S-P	4	2	4½ x 4½	30	1800	B	EL	..	..	22	20	21	550
DIX4B	M-S-P	4	4	3¾ x 4	38.5	2200	B	EL	..	..	30½	21⅛	19	600

(Hercules specifications continued on next page)

Hercules Motors Corp.

(Continued from preceding page)

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
DIX4D	M-S-P	4	4	3⅝ x 4	48.5	2200	B	EL	..	..	30½	21¹¹⁄₁₆	19	600
DOOB	M-S-P	4	4	3⅝ x 4½	48	1800	B	EL-G	..	..	29¾	22½	19¾	750
DOOC	M-S-P	4	4	4 x 4½	55	1800	B	EL-G	..	..	29¾	22½	19¾	750
DOOD	M-S-P	4	4	4¼ x 4½	61.5	1800	B	EL-G	..	..	29¾	22½	19¾	750
DIX6D	M-S-P	4	6	3⅝ x 4	77.5	2200	B	EL-G	..	..	38½	24	19	800
DIX6-272	M-S-P	4	6	3¹¹⁄₁₆ x 4¼	85	2200	B	A-EL-G	..	..	38½	23½	38	800
DJXB	M-S-P	4	6	3½ x 4½	60	1800	B	A-EL-G	..	..	36¼	22½	20⅛	950
DJXC	M-S-P	4	6	3⅝ x 4½	69	1800	B	A-EL-G	..	..	36¼	22½	20⅛	950
DJXH	M-S-P	4	6	3¾ x 4½	79	1800	B	A-EL-G	..	..	36¼	22½	21	950
DJXHF	M-S-P	4	6	3¾ x 4½	79	1800	B	A-EL-G	..	..	38¾	34	13x10⅞	950
DWXC	M-S-P	4	6	4 x 4¾	94	1800	B	A-EL-G	..	..	40¾	26½	24	1350
DWXD	M-S-P	4	6	4¼ x 4¾	107	1800	B	A-EL-G	..	..	40¾	26½	24	1350
DWXLD	M-S-P	4	6	4½ x 5	112	1800	B	A-EL-G	..	..	40¾	26½	24½	1350
DWXLDF	M-S-P	4	6	4½ x 5	106	1800	B	A-EL-G	..	..	37	36⅞	8¾x9	1325
DRXB	M-S-P	4	6	4⅞ x 5¼	106	1600	B	A-EL-G	..	..	44⅜	26	24⅞	1600
DRX-501	M-S-P	4	6	4½ x 5¼	113	1600	B	A-EL-G	..	..	46½	26	38⅛	1600
DRXC	M-S-P	4	6	4⅝ x 5¼	118	1600	B	A-EL-G	..	..	44¾	26	24⅞	1600
DPXB	M-S-P	4	6	5 x 6	160	1600	B	A-EL-G	..	..	55½	29½	30½	2500
DPXC	M-S-P	4	6	5¼ x 6	176	1600	B	A-EL-G	..	..	55½	29½	30½	2500
DPXD	M-S-P	4	6	5½ x 6	191	1600	B	A-EL-G	..	..	55½	29½	30½	2500
DPXE	M-S-P	4	6	5⅝ x 6	199	1600	B	A-EL-G	..	..	55½	29½	30½	2500
DPXE TS	M-S-P	4	6	5⅝ x 6	258	1600	B	A-EL-G	TC	..	74½	28	52	2700
DPXH	M-S-P	4	6	5⅝ x 6	220	1600	B	A-EL-G	..	..	55½	29½	31¹³⁄₁₆	2600
DPXHF	M-S-P	4	6	5⅝ x 6	220	1600	B	A-EL-G	..	..	50¹⁵⁄₁₆	48½	17¼x14⅜	2600
DNX-V-8C	M-S-P	4	8	6 x 6	298	1600	B	A-EL-G	..	..	51½	42	31⅜	4200
DNX-V-8D	M-S-P	4	8	6¼ x 6	325	1600	B	A-EL-G	..	..	51½	42	31⅜	4700
DNX-V-8DTS	M-S-P	4	8	6¼ x 6	450	1600	B	A-EL-G	TC	..	76	42	73	5090

Engines have turbulence-chamber combustion system. All models suitable for marine, stationary or mobile use. Lengths are measured from bellhousing face to front support. Heights are measured from crankshaft to top of cylinder head cover. Weights are approximate and include engine with fuel handling equipment only and no other accessories not forming an integral part of the engine. Various mounting arrangements, flywheel housings, oil pans, manifolds, starting motor and generator locations are available to meet specific applications requirements.

Hill Diesel Engine Corporation
238 Mill Street
Lansing 3, Michigan

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In	Height In.	Weight Lb.
2R	M-S	4	2	3½ x 5½	9– 17	800–1600	B	EL	..	S	48	25	46	1380
4R	M-S	4	4	3½ x 5½	18– 34	800–1600	B	EL	..	S	60	25	46	1740
6R	M-S	4	6	3½ x 5½	27– 54	800–1600	B	EL	..	S or T	72	25	46	2535
4F	M-S	4	4	3¾ x 5½	20– 40	800–1600	B	EL	..	S	60	25	46	1740
6F	M-S	4	6	3¾ x 5½	29– 61	800–1800	B	EL	..	S	72	25	46	2535
6K	M-S	4	6	4¼ x 5½	38– 78	800–1600	B	EL	..	S	74	25	46	2650

Engines have pre-combustion system. Dimensions and weights given are for stationary power units.

Ingersoll-Rand Co.
11 Broadway
New York 4, N. Y.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
T	M-S-P	4	6	7 x 8½	200	1000	O	A-EL	..	RR	86	48	69	9300
TS	M-S-P	4	6	7 x 8½	285	1000	O	A-EL	M	RR	86	48	69	9500
TS	M-S-P	4	8	7 x 8½	380	1000	O	A-EL	M	RR	108	48	69	12200
S	M-S-P	4	6	10½ x 12	450	720	O	A-EL	..	RR	132	40	85	21500
S	M-S-P	4	7	10½ x 12	525	720	O	A-EL	..	RR	149	40	85	24300
S	M-S-P	4	8	10½ x 12	600	720	O	A-EL	..	RR	165	40	85	27800
SS	M-S-P	4	6	10½ x 12	710	720	O	A-EL	TC	RR	132	40	85	23600
SS	M-S-P	4	7	10½ x 12	825	720	O	A-EL	TC	RR	149	40	85	27000
SS	M-S-P	4	8	10½ x 12	945	720	O	A-EL	TC	RR	165	40	85	30600

Engines have open type combustion chambers. RR—Reverse and reduction gear, make not given.

International Harvester Company
180 North Michigan Avenue
Chicago, Illinois

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
UD-264	S-P	4	4	4 x 5½	52	1600	O	G-EL	..	..	62⅛	26⅛	47	1835
UD-9A	S-P	4	4	4.4 x 5.5	62.5	1600	O	G-EL	..	..	67¾	28⅛	52	2060
UD-14A	S-P	4	4	4⅝ x 6½	76	1400	O	G-EL	..	..	78	33½	56½	2650
UD-16	S-P	4	6	4.4 x 5.5	100	1800	O	G-EL	..	..	88¼	33¼	55⅛	3015
UD-18A	S-P	4	6	4⅝ x 6½	125	1600	O	G-EL	..	..	95⅞	35⅞	59¾	4000
UD-24	S-P	4	6	5¾ x 7	180	1375	O	G-EL	..	..	107⅛	44	72	5800

Horsepower shown is net for complete power unit with radiator and fan as obtained at sea level with regular production injection pump setting. Dimensions include radiator and direct drive rear power take-off.

Kahlenberg Brothers Company
Two Rivers, Wisconsin

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
AD	M	2	2	....	30– 36	375–400	O	A	..	†	..	..	..	4450
AT	M	2	3	....	45– 54	375–400	O	A	..	*	..	..	..	6500
BD	M	2	2	....	50– 60	340–375	O	A	..	†	..	..	..	7300
AF	M	2	4	....	70	375–400	O	A	..	*	..	..	..	8200
BT	M	2	3	....	90	340–375	O	A	..	*	..	..	..	9700

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
BP	M	2	4	....	120	340–375	O	A	..	*	..	..	..	11080
B5	M	2	5	....	150	340–375	O	A	..	*	..	..	..	15650
CT	M	2	3	....	150	275–325	O	A	..	*	..	..	..	21730
B6	M	2	6	....	180	340–375	O	A	..	*	..	..	..	17050
CP	M	2	4	....	200	275–325	O	A	..	*	..	..	..	23900
C5	M	2	5	....	250	275–325	O	A	..	D	..	..	..	29000
C6	M	2	6	....	300	275–325	O	A	..	D	..	..	..	34000

*All engines have pre-combustion chambers. † Reverse gear used. * Direct reverse. Reverse gear optional.*

Kermath Manufacturing Company
5890 Commonwealth Avenue
Detroit, Michigan

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In	Height In.	Weight Lb.
2-127	M	4	2	4¼ x 4½	27	1800	B	EL&H	..	S	37	25⅞	30⅝	900
4-226	M	4	4	4 x 4½	60	2600	B	EL	..	S	47⅞	24	33	1250
6-298	M	4	6	3¾ x 4½	75	2000	B	EL	..	S	54¾	25½	33	1550
6-529	M	4	6	4⅝ x 5¼	130	1800	B	EL	..	S	62⅛	27⅝	37¹⁰⁄₁₆	2450
6-935	M	4	6	5¾ x 6	250	2000	B	EL	..	C	88⅛	36⅜	50¼	5000

All engines have turbulence chamber type combustion system.

The Lathrop Engine Co.
Mystic, Conn.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. H.P.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
D50	M	4	4	5½ x 7	50	800	B	EL	..	O	75	29	31	3000
D60	M	4	4	5½ x 7	60	900	B	EL	..	O	75	29	31	3000
D80	M	4	6	5½ x 7	80	800	B	EL	..	S	96¼	30½	31	4200
D90	M	4	6	5½ x 7	90	900	B	EL	..	S	96¼	30½	31	4200
D100	M	4	6	5½ x 7	100	1000	B	EL	..	S	92½	30½	31	4000
DH-200	M	4	6	5¾ x 6	187	1600	B	EL	..	C	96	38¾	43¼	5100

Mack Manufacturing Corporation
5th Avenue & 34th Street
New York, N. Y.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
END510*	P	4	6	4⅞ x 5½	138	2400	B	EL	..	..	49½	32½	45⅝	1991
ENDS672†	P	4	6	4⅞ x 6	222	2000	B	EL	M	..	60	32½	42½	2240
END673*†	P	4	6	4⅞ x 6	170	2100	B	A-EL	..	..	53½	29	46	2150

** Truck engine. † Bus engine. Energy cell combustion systems on END 510 and ENDS 672 only.*

Mechanical Equipment Company
861 Carondelet Corner St. Joseph Sts.
New Orleans 13, Louisiana

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
B6	M	4	6	3¾ x 4	70	2600	B	EL	..	S	51¹⁰⁄₁₆	22	16⅜	1050
D6	M	4	6	5¾ x 6	175	1900	B	EL-G-A	..	S	71⅛	24¼	29⅞	2950
E6	M	4	6	6¼ x 6½	202	1600	B	EL-G-A	..	S	94	26	37⅛	5100
G6	M	4	6	8½ x 8½	340	1050	B	EL-G-A	..	S	144⁷⁄₁₆	32½	49¾	11950

Pre-combustion chambers are used on all engines. Horsepower ratings are maximum. Height above shaft is given.

Murphy Diesel Company
5317 West Burnham Street
Milwaukee, Wisconsin

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
ME4	P	4	4	5¾ x 6½	90	1200	O	EL	..	..	70	42⅝	65⅛	3800
11	P	4	4	5¾ x 6½	100– 110	1200–1400	O	EL	..	..	70	42⅝	65⅛	3800
12	P	4	4	6 x 6½	110– 120	1200–1400	O	EL	..	..	70	42⅝	65⅛	3800
111	P	4	4	5¾ x 6½	115– 125	1200–1400	O	EL	**	..	70	42⅝	65⅛	3900
112	P	4	4	6 x 6½	125– 135	1200–1400	O	EL	**	..	70	42⅝	65⅛	3900
20*	P	4	6	5½ x 6½	135– 145	1200–1400	O	EL	..	..	92½	42⅝	65⅛	4700
120	P	4	6	5½ x 6½	145– 157	1200–1400	O	EL	**	..	92½	42⅝	65⅛	4800
21*	P	4	6	5¾ x 6½	150– 162	1200–1400	O	EL	..	..	92½	42⅝	65⅛	4700
22*	P	4	6	6 x 6½	165– 178	1200–1400	O	EL	..	..	92½	42⅝	65⅛	4700
121	P	4	6	5¾ x 6½	170– 184	1200–1400	O	EL	**	..	92½	42⅝	65⅛	4800
122	P	4	6	6 x 6½	190– 205	1200–1400	O	EL	**	..	92½	42⅝	65⅛	4800
ME90	M	4	4	5¾ x 6½	90	1200	O	EL	..	T	91	39	63	6500
M100	M	4	4	5¾ x 6½	100	1200	O	EL	..	T	91	39	63	6650
M110	M	4	4	6 x 6½	110	1200	O	EL	..	T	91	39	63	6685
M115	M	4	4	5¾ x 6½	115	1200	O	EL	..	T	91	39	63	6830
M125	M	4	4	6 x 6½	125	1200	O	EL	..	T	91	39	63	6860
M135	M	4	6	5½ x 6½	135– 145	1200–1400	O	EL	..	S-T	115	38	61	7940
M145	M	4	6	5½ x 6½	145– 157	1200–1400	O	EL	**	S-T	115	38	55	8255
M150	M	4	6	5¾ 6½	150– 162	1200–1400	O	EL	..	S-T	115	38	61	8000
M165	M	4	6	6 x 6½	165– 178	1200–1400	O	EL	..	T	115	38	61	8000
M170	M	4	6	5¾ x 6½	170– 184	1200–1400	O	EL	**	T	115	38	55	8265
M190	M	4	6	6 x 6½	190– 205	1200–1400	O	EL	**	T	115	38	55	8265

*All engines have open type combustion chambers and unit injectors. * Stationary models available as dual-fuel and crude oil engine. **Tubo supercharging manifold. Higher of dual ratings is accompanied with change in model number. For portable engines, "2" is prefixed in the case of two letter numbers and added to the first in the case of three (111 becomes 311, etc.). For marine engines "A" follows the "M" and in turn is followed by the higher horsepower (M135 becomes MA145, etc.)*

The National Supply Company
Engine Division, Mfgrs. of Superior and Atlas Engines
1401 Sheridan Ave., Springfield 2, Ohio

Superior Engines

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
40-6	S-M	4	6	8½ x 10½	215- 325	600- 900	..	..	..	..	..	..	..	....
40-8	S-M	4	8	8½ x 10½	290- 435	600- 900	..	..	..	..	..	..	..	....
40-X-6	S-M	4	6	8½ x 10½	325- 525	600- 900	..	..	TC	..	..	..	..	....
40-X-8	S-M	4	8	8½ x 10½	435- 700	600- 900	..	..	TC	..	..	..	..	....
60-6	S-M	4	6	12 x 15	410- 530	400- 514	..	..	..	..	..	..	..	....
60-8	S-M	4	8	12 x 15	550- 615	400- 450	..	..	..	..	..	..	..	....
60-X-6	S-M	4	6	12 x 15	615- 795	400- 514	..	..	TC	..	..	..	..	....
60-X-8	S-M	4	8	12 x 15	825- 925	400- 450	..	..	TC	..	..	..	..	....
65-6	S-M	4	6	12¾ x 15	580- 700	500- 600	..	..	..	..	..	..	..	....
65-8	S-M	4	8	12¾ x 15	775- 930	500- 600	..	..	..	..	..	..	..	....
65-X-6	S-M	4	6	12¾ x 15	1105-1325	500- 600	..	..	TC	..	..	..	..	....
65-X-8	S-M	4	8	12¾ x 15	1470-1765	500- 600	..	..	TC	..	..	..	..	....
80-6	S-M	4	6	14½ x 20	600- 720	300- 360	..	..	..	..	..	..	..	....
80-8	S-M	4	8	14½ x 20	800- 960	300- 360	..	..	..	..	..	..	..	....
80-X-6	S-M	4	6	14½ x 20	900-1080	300- 360	..	..	TC	..	..	..	..	....
80-X-8	S-M	4	8	14½ x 20	1200-1440	300- 360	..	..	TC	..	..	..	..	....

Atlas Engines

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
35-4	S	4	4	6½ x 8¼	100- 130	900-1200	..	..	..	..	..	..	..	....
35-6	S	4	6	6½ x 8¼	150- 190	900-1200	..	..	..	..	..	..	..	....
35-X-6	S	4	6	6½ x 8¼	225- 300	900-1200	..	..	TC	..	..	..	..	....
45-4	S	4	4	9 x 10½	160- 190	600- 720	..	..	..	..	..	..	..	....
45-5	S	4	5	9 x 10½	200- 240	600- 720	..	..	..	..	..	..	..	....
45-6	S	4	6	9 x 10½	240- 300	600- 750	..	..	..	..	..	..	..	....
45-8	S	4	8	9 x 10½	320- 400	600- 750	..	..	..	..	..	..	..	....
45-X-6	S	4	6	9 x 10½	360- 450	600- 756	..	..	TC	..	..	..	..	....
45-X-8	S	4	8	9 x 10½	480- 600	600- 750	..	..	TC	..	..	..	..	....
58-6	S	4	6	11½ x 15	320- 350	327- 360	..	..	..	..	..	..	..	....
75-6	S	4	6	13 x 16	425	327- 333	..	..	..	..	..	..	..	....
75-X-6	S	4	6	13 x 16	600	327- 333	..	..	TC	..	..	..	..	....
76-6	S	4	6	13 x 16	460- 500	360- 400	..	..	..	..	..	..	..	....
76-X-6	S	4	6	13 x 16	675- 750	360- 400	..	..	TC	..	..	..	..	....
85-6	S	4	6	15 x 19	650	327- 333	..	..	..	..	..	..	..	....
85-X-6	S	4	6	15 x 19	1000	327- 333	..	..	TC	..	..	..	..	....
35-4	M	4	4	6½ x 8¼	110	1000	..	..	..	..	..	..	..	....
35-6	M	4	6	6½ x 8¼	150- 190	900-1200	..	..	..	..	..	..	..	....
35-X-6	M	4	6	6½ x 8¼	225- 300	900-1200	..	..	TC	..	..	..	..	....
38-4	M	4	4	8 x 10½	85*	450	..	..	..	..	..	..	..	....
45-4	M	4	4	9 x 10½	160	600	..	..	..	..	..	..	..	....
45-5	M	4	5	9 x 10½	200	600	..	..	..	..	..	..	..	....
45-6	M	4	6	9 x 10½	240- 300	600- 750	..	..	..	..	..	..	..	....
45-8	M	4	8	9 x 10½	320- 400	600- 750	..	..	..	..	..	..	..	....
45-X-6	M	4	6	9 x 10½	360- 450	600- 750	..	..	TC	..	..	..	..	....
45-X-8	M	4	8	9 x 10½	480- 600	600- 750	..	..	TC	..	..	..	..	....
48-4	M	4	4	9 x 12	110*	325	..	..	..	..	..	..	..	....
55-6	M	4	6	10½ x 13	250	350	..	..	..	..	..	..	..	....
58-6	M	4	6	11½ x 15	320- 350	325- 360	..	..	..	..	..	..	..	....
75-6	M	4	6	13 x 16	425	325	..	..	..	..	..	..	..	....
75-X-6	M	4	6	13 x 16	600	325	..	..	TC	..	..	..	..	....
85-6	M	4	6	15 x 19	650	325	..	..	..	..	..	..	..	....
85-X-6	M	4	8	15 x 19	1000	325	..	..	TC	..	..	..	..	....

** With reduction gear or reverse gear, the friction loss in gear must be deducted from the engine rating to obtain net horsepower delivered to propeller shaft. Exceptions are Models 38-4 and 48-4, for which the net horsepower delivered to propeller shaft is shown.*

Lister Engines

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
3½-1	S	4	1	3¾ x 5½	3½	650	B	H	..	..	35½	24	40	750
6-1	S	4	1	4½ x 5½	6	650	B	H	..	..	35½	24	40	760
12-2	S	4	2	4½ x 5½	12	650	B	H	..	..	50	24	40	1130
FR1	M-S	4	1	3¾ x 4½	9	1800	B	H-EL	..	O	26⅞	22⅜	35⅝	750
FR2	M-S	4	2	3¾ x 4½	18	1800	B	H-EL	..	O	31 1/16	22½	35⅝	970
FR3	M-S	4	3	3¾ x 4½	27	1800	B	H-EL	..	O	37	22½	35⅝	1100
FR4	M-S	4	4	3¾ x 4½	36	1800	B	H-EL	..	O	43¼	22½	35⅝	1270
FR6	M-S	4	6	3¾ x 4½	54	1800	B	H-EL	..	O	53¾	22½	35⅝	1590
21-2	M-S	4	2	4½ x 5½	21	1200	B	H-A-EL	..	O	47¾	25	40½	1625
30-3	M-S	4	3	4½ x 5½	30	1200	B	H-A-EL	..	O	57½	25	40½	2040
40-4	M-S	4	4	4½ x 5½	40	1200	B	H-A-EL	..	O	66¾	25	40½	2275
61-6	M-S	4	6	4½ x 5½	63	1200	B	A-EL	..	O	74½	32	43½	3000

Nordberg Manufacturing Company
Milwaukee, Wisconsin

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
4FS-1	S	4	1	4½ x 5¼	10- 15	1200-1800	..	EL-H	..	..	..	..	..	....
4FS-2	S	4	2	4½ x 5¼	20- 30	1200-1800	..	EL-H	..	..	..	..	..	....
4FS-3	S	4	3	4½ x 5¼	30- 45	1200-1800	..	EL-H	..	..	..	..	..	....
FS-95	S	4	5	9 x 11½	220- 265	600- 720	..	A	..	..	..	..	..	....
FS-96	S	4	6	9 x 11½	265- 440	600-1000	..	A	..	..	..	..	..	....
FS-97	S	4	7	9 x 11½	310- 370	600- 720	..	A	..	..	..	..	..	....
FS-98	S	4	8	9 x 11½	355- 590	600-1000	..	A	..	..	..	..	..	....
FS-95-SC	S	4	5	9 x 11½	330- 400	600- 720	..	A	TC	..	..	..	..	....
FS-96-SC	S	4	6	9 x 11½	400- 665	600-1000	..	A	TC	..	..	..	..	....
FS-97-SC	S	4	7	9 x 11½	465- 555	600- 720	..	A	TC	..	..	..	..	....
FS-98-SC	S	4	8	9 x 11½	530- 885	600-1000	..	A	TC	..	..	..	..	....
FS-96-SC*	S	4	6	9 x 11½	535- 890	600-1000	..	A	TC	..	..	..	..	....
FS-97-SC*	S	4	7	9 x 11½	620- 745	600- 720	..	A	TC	..	..	..	..	....
FS-98-SC*	S	4	8	9 x 11½	710-1180	600-1000	..	A	TC	..	..	..	..	....
FS-135	S	4	5	13 x 16½	500- 570	450- 514	..	A	..	..	..	..	..	....
FS-136	S	4	6	13 x 16½	600- 800	450- 600	..	A	..	..	..	..	..	....
FS-137	S	4	7	13 x 16½	700- 800	450- 514	..	A	..	..	..	..	..	....
FS-138	S	4	8	13 x 16½	800-1065	450- 600	..	A	..	..	..	..	..	....
FS-135-SC	S	4	5	13 x 16½	750- 850	450- 514	..	A	TC	..	..	..	..	....
FS-136-SC	S	4	6	13 x 16½	900-1200	450- 600	..	A	TC	..	..	..	..	....
FS-137-SC	S	4	7	13 x 16½	1050-1200	450- 514	..	A	TC	..	..	..	..	....
FS-138-SC	S	4	8	13 x 16½	1200-1600	450- 600	..	A	TC	..	..	..	..	....

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
FS-136-SC*	S	4	6	13 x 16½	1200–1600	450– 600	..	A	TC	..	..	..	..	....
FS-137-SC*	S	4	7	13 x 16½	1400–1585	450– 514	..	A	TC	..	..	..	..	....
FS-138-SC*	S	4	8	13 x 16½	1600–2130	450– 600	..	A	TC	..	..	..	..	....
FS-1312-SC*	S	4	12	13 x 16½	2400–3200	450– 600	..	A	TC	..	..	..	..	....
FS-1316-SC*	S	4	16	13 x 16½	3200–4260	450– 600	..	A	TC	..	..	..	..	....
FS-165	S	4	5	16 x 22	730	327	..	A	..	..	..	..	..	....
FS-166	S	4	6	16 x 22	875	327	..	A	..	..	..	..	..	....
FS-167	S	4	7	16 x 22	1020	327	..	A	..	..	..	..	..	....
FS-168	S	4	8	16 x 22	1165	327	..	A	..	..	..	..	..	....
FS-165-SC	S	4	5	16 x 22	1090	327	..	A	TC	..	..	..	..	....
FS-166-SC	S	4	6	16 x 22	1310	327	..	A	TC	..	..	..	..	....
FS-167-SC	S	4	7	16 x 22	1530	327	..	A	TC	..	..	..	..	....
FS-168-SC	S	4	8	16 x 22	1750	327	..	A	TC	..	..	..	..	....
FS-166-SC*	S	4	6	16 x 22	1750	327	..	A	TC	..	..	..	..	....
FS-167-SC*	S	4	7	16 x 22	2040	327	..	A	TC	..	..	..	..	....
FS-168-SC*	S	4	8	16 x 22	2340	327	..	A	TC	..	..	..	..	....
5DB-24½	S	4	5	16½ x 24½	735– 795	277– 300	..	A	..	..	..	..	..	....
6DB-24½	S	4	6	16½ x 24½	880– 955	277– 300	..	A	..	..	..	..	..	....
7DB-24½	S	4	7	16½ x 24½	1030–1115	277– 300	..	A	..	..	..	..	..	....
8DB-24½	S	4	8	16½ x 24½	1175–1270	277– 300	..	A	..	..	..	..	..	....
5DBT-24½	S	4	5	16½ x 24½	1100–1190	277– 300	..	A	TC	..	..	..	..	....
6DBT-24½	S	4	6	16½ x 24½	1320–1430	277– 300	..	A	TC	..	..	..	..	....
7DBT-24½	S	4	7	16½ x 24½	1540–1670	277– 300	..	A	TC	..	..	..	..	....
8DBT-24½	S	4	8	16½ x 24½	1760–1900	277– 300	..	A	TC	..	..	..	..	....
RTS-1411	S	2	11	14 x 16	1950	400	..	A	..	..	..	..	..	....
RTS-1412	S	2	12	14 x 16	2125	400	..	A	..	..	..	..	..	....
TS-175	S	2	5	17½ x 25	1570–1700	277– 300	..	A	..	..	..	..	..	....
TS-176	S	2	6	17½ x 25	1890–2040	277– 300	..	A	..	..	..	..	..	....
TS-177	S	2	7	17½ x 25	2200–2380	277– 300	..	A	..	..	..	..	..	....
TS-178	S	2	8	17½ x 25	2520–2720	277– 300	..	A	..	..	..	..	..	....
TS-179	S	2	9	17½ x 25	2830–3060	277– 300	..	A	..	..	..	..	..	....
TS-215-31	S	2	5	21½ x 31	2400–2550	225– 240	..	A	..	..	..	..	..	....
TS-216-31	S	2	6	21½ x 31	2900–3100	225– 240	..	A	..	..	..	..	..	....
TS-217-31	S	2	7	21½ x 31	3350–3600	225– 240	..	A	..	..	..	..	..	....
TS-218-31	S	2	8	21½ x 31	3850–4100	225– 240	..	A	..	..	..	..	..	....
TS-219-31	S	2	9	21½ x 31	4300–4600	225– 240	..	A	..	..	..	..	..	....
TS-2110-31	S	2	10	21½ x 31	4800–5100	225– 240	..	A	..	..	..	..	..	....
TS-2111-31	S	2	11	21½ x 31	5300–5600	225– 240	..	A	..	..	..	..	..	....
TS-2112-31	S	2	12	21½ x 31	5750–6100	225– 240	..	A	..	..	..	..	..	....
TS-295	S	2	5	29 x 40	4300–4500	171– 180	..	A	..	..	..	..	..	....
TS-296	S	2	6	29 x 40	5100–5400	171– 180	..	A	..	..	..	..	..	....
TS-297	S	2	7	29 x 40	6000–6300	171– 180	..	A	..	..	..	..	..	....
TS-298	S	2	8	29 x 40	6800–7200	171– 180	..	A	..	..	..	..	..	....
TS-299	S	2	9	29 x 40	7700–8100	171– 180	..	A	..	..	..	..	..	....
TS-2910	S	2	10	29 x 40	8500–9000	171– 180	..	A	..	..	..	..	..	....
TS-2911	S	2	11	29 x 40	9400–9900	171– 180	..	A	..	..	..	..	..	....
TS-2912	S	2	12	29 x 40	10200–10800	171– 180	..	A	..	..	..	..	..	....

These engines are designed to operate continuously at the ratings shown and are good for 10 per cent overload for 2 hours in any 24 hour period.
** Supairthermal Execution.*

Osco Motors Corporation
3627 W. Lawrence Street
Philadelphia, Pennsylvania

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
235D	M-S	4	2	4 x 4½	28	1800	B	EL	..	P	38	27⅛	36¾	850†-1027*
235X	M-S	4	2	4 x 4½	28	1800	B	EL	..	P	45⅛	27⅛	36¾	910†-1075*
235Z	M-S	4	2	4 x 4½	28	1800	B	EL	..	P	45⅛	27⅛	36¾	925†-1088*
470D	M-S	4	4	4 x 4½	70	2600	B	EL	..	P	45⅞	22	35⅓	1200†-1385*
470TD-2	M-S	4	4	4 x 4½	76	2600	B	EL	..	T	49⅛	22	35⅓	1260†-1417*
470TD-3	M-S	4	4	4 x 4½	70	2600	B	EL	..	T	49⅛	22	35⅓	1275†-1430*
685D	M-S	4	6	3¾ x 4½	85	2600	B	EL	..	P	52⅞	22	37⅞	1365†-1423*
685TD-2	M-S	4	6	3¾ x 4½	85	2600	B	EL	..	T	60½	22	37⅞	1430†-1513*
685TD-3	M-S	4	6	3¾ x 4½	85	2600	B	EL	..	T	60½	22	37⅞	1450†-1526*

** Marine weight. † Stationary weight.*

Page Engineering Compan,
Clearing Post Office
Chicago 38, Illinois

Model	Use	Cycle	No, Cyl.	Bore & Stroke In.	Cont, HP.	Cont, R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weigh Lb.
9½ x 12½	P	4	3	9½ x 12½	135	500	BS	A	..	..	72	84	42	12750
11 x 15	P	4	3	11 x 15	195	450	BS	A	..	..	82	99	51	16750
11 x 15	P	4	4	11 x 15	260	450	BS	A	..	..	104½	99	51	22330
11 x 15	P	4	5	11 x 15	325	450	BS	A	..	..	122	99	51	27750
12½ x 16	P	4	3	12½ x 16	270	450	BS	A	..	..	90½	110½	55	21750
12½ x 16	P	4	4	12½ x 16	360	450	BS	A	..	..	114	110½	55	29330
12½ x 16	P	4	5	12½ x 16	450	450	BS	A	..	..	132½	110½	55	36200
12½ x 16	P	4	6	12½ x 16	540	450	BS	A	..	..	156	110½	55	43500
11 x 15V	P	4	6	11 x 15	400	450	BS	A	..	..	111	102	73	39000
12½ x 16V	P	4	6	12½ x 16	540	450	BS	A	..	..	122½	115	83	41000
12½ x 16V	P	4	8	12½ x 16	725	450	BS	A	..	..	153½	115	83	52000

All engines are of the horizontal type and are designed especially for dragline excavator service.

Palmer Brothers Engine Corporation
Cos Cob, Connecticut

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
RND-1	S	4	1	4½ x 6	9	1000	B	H	..	..	31½	25*	41	900
RND-4	M-S	4	4	4½ x 6	40	1200	B	EL-H	..	O	72	26¾	42	2500
RND-6	M-S	4	6	4½ x 6	60	1200	B	EL-H	..	O	88½	24½	45	3200
RND-4G2	M-S	4	4	4½ x 6	40	1200	B	EL-H	..	O	80	26¾	42	2590
RND-6G2	M-S	4	6	4½ x 6	60	1200	B	EL-H	..	O	95½	24½	45	3360
PM-672	M-S	4	6	4½ x 6	120	1600	B	EL	..	T	79¾	26	29¼	3400

RND models have Russell-Newbury turbulence chamber. Height is given above shaft centerline.

Rathbun-Jones Engineering Company
Toledo, Ohio

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
18	S	4	3	11 x 18	220	450	O	A	..	..	158	70	106	26000
18	S	4	4	11 x 18	290	450	O	A	..	..	177	70	106	31500
18	S	4	5	11 x 18	364	450	O	A	..	..	196	70	106	36300
18	M-S	4	6	11 x 18	435	450	O	A	..	D	215	70	106	37600*-41200†
18	M-S	4	7	11 x 18	510	450	O	A	..	D	238	70	106	41900*-46000†
18	M-S	4	8	11 x 18	580	450	O	A	..	D	258	70	106	46500*-51000†
22	S	4	3	15½ x 22	388	327	O	A	..	..	175	80	126	41500
22	S	4	4	15½ x 22	518	327	O	A	..	..	197	80	126	50000
22	S	4	5	15½ x 22	650	327	O	A	..	..	225	80	126	58500
22	M-S	4	6	15½ x 22	775	327	O	A	..	D	247	80	126	64000*-68000†
22	M-S	4	7	15½ x 22	910	327	O	A	..	D	271	80	126	71000*-75500†
22	M-S	4	8	15½ x 22	1035	327	O	A	..	D	293	80	126	82000*-85000†
24	S	4	3	18¾ x 24	540	300	O	A	..	..	200	85	140	60000
24	S	4	4	18¾ x 24	720	300	O	A	..	..	231	85	140	74000
24	S	4	5	18¾ x 24	900	300	O	A	..	..	258	85	140	87000
24	M-S	4	6	18¾ x 24	1080	300	O	A	..	D	294	85	140	90000*-98000†
24	M-S	4	7	18¾ x 24	1260	300	O	A	..	D	321	85	140	103000*-110000†
24	M-S	4	8	18¾ x 21	1440	300	O	A	..	D	348	85	140	116000*-120000†
28	S	4	5	19½ x 28	1025	257	O	A	..	..	332	104	171	140000
28	M-S	4	6	19½ x 28	1230	257	O	A	..	D	339	104	171	160000*-164000†
28	M-S	4	7	19½ x 28	1435	257	O	A	..	D	380	104	171	184000*-187000†
28	M-S	4	8	19½ x 28	1640	257	O	A	..	D	409	104	171	209000*-212000†
28	S	4	10	19½ x 28	2050	257	O	A	..	..	460	104	171	230000
28	S	4	12	19½ x 28	2460	257	O	A	..	..	528	104	171	260000

*Engines have Price turbulence chamber combustion system and Rathbun distributor type fuel injection system. Lengths listed are approximate for stationary engines and include generator, exciter drive and outboard bearing. Widths include operating platforms. Marine lengths including thrust bearing are considerably shorter. All engines can be furnished for dual-fuel operation. * Marine weight. † Stationary weight.*

Red Wing Motor Company
Red Wing, Minnesota

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
H4-54	M	4	4	4 x 5	42- 54	1500	B	EL	..	P	49	17½	32	1000
H4-60	M	4	4	5⅛ x 5¼	55- 60	1400	B	EL	..	P	53	17½	34	1200
H6-140	M	4	6	4½ x 5½	100- 140	1500	B	EL	..	S	72	24½	40	2000
D4-30	M	4	4	3⅝ x 3½	30	1800	B	EL	..	S	43	24½	29½	825
D-65	M	4	4	4¼ x 4½	65	1900	B	EL	..	P	57	23½	35	1400
D6-160	M	4	6	5¼ x 6	160	1400	B	EL	..	S	75	27	34	3000
D6-200	M	4	6	6¼ x 6½	200	1300	B	EL	..	S	86	36	36	5000

"H" models are Waukesha-Hesselman units adapted for marine use. "D" model is full compression ignition diesel engine.

R. H. Sheppard Company, Incorporated
Hanover, Pennsylvania

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
14*	S	4	1	3 x 4	3¾	1800	O	H-EL	..	..	22½	20¾	28½	415
14C*	M	4	1	3 x 4	3¾	1800	O	H-EL	..	P	37	21⅜	29⅜	490
8	S	4	1	3 x 4	3¾	1800	O	H-EL	..	..	22½	20¾	28½	420
17	S	4	2	3½ x 4	13.5	1800	O	H-EL	..	..	27	21½	31	550
7	S	4	1	4 x 5	10	1800	O	H-EL	..	..	37	30¾	49½	1090
7D	S	4	1	4¼ x 5	11	1800	O	H-EL	..	..	37	30¾	49½	1090
7C	M	4	1	4 x 5	8	1200	O	H-EL	..	S	37⅛	23½	41¾	1100
7F	M	4	1	4¼ x 5	9	1200	O	H-EL	..	..	37⅛	23½	41¾	1100
13	S	4	2	4 x 5	18	1400	O	H-EL	..	..	42⅜	19¼	45	1365
13D	S	4	2	4¼ x 5	22	1800	O	H-EL	..	..	42⅜	19¼	45	1365
13C	M	4	2	4 x 5	20	1800	O	H-EL	..	S	44	23½	37¾	1500
13F	M	4	2	4¼ x 5	22	1800	O	H-EL	..	S	44	23½	37¾	1500
6	S	4	3	4 x 5	28	1400	O	H-EL	..	..	53⅞	25	46½	1662
6D	S	4	3	4¼ x 5	34	1800	O	H-EL	..	..	53⅞	25	46½	1662
6C	M	4	3	4 x 5	30	1800	O	H-EL	..	S	51⅞	23½	37¾	1865
6F	M	4	3	4¼ x 5	34	1800	O	H-EL	..	S	51⅞	23½	37¾	1865
12	S	4	6	4 x 5	61	1800	O	EL	..	..	69½	24	49¾	2100
12D	S	4	6	4¼ x 5	67	1800	O	EL	..	..	69½	24	49¾	2100
12C	M	4	6	4 x 5	61	1800	O	EL	..	S	71	24½	40¾	2250
12F	M	4	6	4¼ x 5	67	1800	O	EL	..	S	71	24½	40¾	2250

*All engines have pre-combustion type chambers. * Air cooled.*

Sterling Engine Company
Buffalo, New York

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb
1AB-6	S	4	6	4½ x 5¾	72- 110	1400-1800	B	EL	..	..	57⅝	30	52⅝	3150
MAB-6	M	4	6	4½ x 5¾	72- 110	1400-1800	B	EL	..	S	66⅛	33¼	38⅞	2650
MRAB-6	M	4	6	4½ x 5¾	72- 110	1400-1800	B	EL	..	S	75⅛	33¼	38⅞	2800
1DB-6	S	4	6	5½ x 7	114- 170	1200-1500	B	EL	..	..	39⅛	36	59¼	5200
MDB-6	M	4	6	5½ x 7	114- 170	1200-1500	B	EL	..	S	87⅛	39⅛	49¼	4700
MRDB-6	M	4	6	5½ x 7	114- 170	1200-1500	B	EL	..	S	97⅛	39⅛	49¼	5000
1DB-8	S	4	8	5½ x 7	152- 230	1200-1500	B	EL	..	..	74⅛	36	59¼	6850
MDB-8	M	4	8	5½ x 7	152- 230	1200-1500	B	EL	..	S	103⅛	39⅛	49¼	5850
MRDB-8	M	4	8	5½ x 7	152- 230	1200-1500	B	EL	..	S	120⅛	39⅛	49¼	6400
VDS-6	S	4	6	8 x 9	325- 470	1200-1500	BS	EL-A	..	..	95	39¼	63¼	8500
VDM-6	M	4	6	8 x 9	325- 470	1200-1500	BS	EL-A	..	S-T	136⅜*	40½	67½	12000
VDS-6-S	S	4	6	8 x 9	660- 940	1200-1500	B	EL-A	TC	..	114¼	39¼	63½	9160
VDM-6-S	M	4	6	8 x 9	660- 940	1200-1500	B	EL-A	TC	S	141	40½	70¼	13600
VDS-8-S	S	4	8	8 x 9	880-1250	1200-1500	B	EL-A	TC	..	134⅝	39¼	64	12450

*All engines have open type combustion chambers. Dual listings indicate continuous and intermittent ratings. *Snow-Nabstedt; for Twin Disc—add 9⅛ in.*

Sun Shipbuilding and Dry Dock Co.
Chester, Pennsylvania

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
510-LB-3	M	2	3	20 1/16 x 44 1/2 +33 1/16	1500	90	O	A	..	D	444	132	336	322000
540-L-4	M	2	4	21 1/4 x 42 1/2 +42 1/2	2500	90	O	A	..	D	576	132	361 7/8*	470000
580-L-4	M	2	4	22 5/16 x 45 5/8 +45 5/8	2800	80	O	A	..	D	612	134	389	580000
600-L-4	M	2	4	23 5/8 x 45 5/8 +45 5/8	3000	80	O	A	..	D	624	134	389	625000
600-LB-4	M	2	4	23 5/8 x 45 5/8 +33 7/16	2700	100	O	A	..	D	624	134	384 1/4*	600000
640-LB-6	M	2	6	25 1/16 x 45 5/8 +33 7/16	5600	100	O	A	..	D	816	134	426 1/2*	930000
26-LB-4	M	2	4	26 x 46 +33	3600	115	O	A	..	D	623 3/4	134	400 1/2*	655000
31-LB-4	M	2	4	31 x 50 +36	4800	90	O	A	..	D	729	152	432 7/8*	1015000
31-LB-5	M	2	5	31 x 50 +36	7200	100	O	A	..	D	807 3/4	152	406 1/2	1166000
32-LB-4	M	2	4	32 x 55 +40	6000	94	O	A	..	D	735 1/16	152	427	1052000
32-LB-5	M	2	5	32 x 55 +40	7500	94	O	A	..	D	861 11/16	152	489 1/4*	1342000
21-LB-6†	M	2	6	21 x 35 +25	4500	180	O	A	..	D	601 7/8	126 1/4	292	450000
...	S	2	4	21 x 35 +25	3000	200	..	..	..	..	539 1/4	126 1/4	315*	366000
...	S	2	5	21 x 35 +25	3800	200	..	..	..	..	628 1/2	126 1/4	325*	458000
...	S	2	6	21 x 35 +25	4500	200	..	..	..	..	718	126 1/4	333*	550000
...	S	2	4	26 x 46 +33	4500	150	..	..	..	..	623 3/4	134	400 1/2*	655000
...	S	2	5	26 x 46 +33	6000	150	..	..	..	..	756 3/4	134	399*	820000
...	S	2	6	26 x 46 +33	7500	150	..	..	..	..	862 1/2	134	411*	985000
...	S	2	4	32 x 55 +40	9000	138	..	..	..	..	735 3/4	152	467 1/4*	1145000
...	S	2	5	32 x 55 +40	11200	138	..	..	..	..	861 3/4	152	489 1/4*	1342000
...	S	2	6	32 x 55 +40	13500	138	..	..	..	..	1092	152	443 1/4*	1700000

*Engines are of the opposed-piston type. † Drives through reduction gear (Ratio 2.092 to 1) Maximum heights shown. * Height to top of scavenging air pump. Other figures show cylinder height.*

Union Diesel Engine Co.
Oakland, Calif.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Heigth In.	Weight Lb.
GA6	S-M	4	6	8 1/2 x 11	175- 225	475- 600	O	A	..	D	144	34	68	14000
GA6S	S-M	4	6	8 1/2 x 11	260- 330	475- 600	O	A	TC	D	146	34	68	15000
L6	S-M	4	6	10 x 14	230- 340	350- 514	O	A	..	D	175	42	85	23500
L6S	S-M	4	6	10 x 14	340- 500	350- 514	O	A	TC	D	178	42	85	24500
P6	S-M	4	6	12 x 15	410- 525	400- 514	O	A	..	D	194	46	93	36500
P6S	S-M	4	6	12 x 15	600- 700	400- 514	O	A	TC	D	194	46	93	38000
V6	S-M	4	6	14 x 19	560- 700	325- 400	O	A	..	D	242	57	114	58000
V6S	S-M	4	6	14 x 19	740-1000	325- 400	O	A	TC	D	242	57	114	60000
Z6	S-M	4	6	16 x 20 1/2	600- 750	240- 300	O	A	..	D	275	62	125	87500
Z6S	S-M	4	6	16 x 20 1/2	900-1125	240- 300	O	A	TC	D	285	62	125	90000
GA8	S-M	4	8	8 1/2 x 11	235- 300	450- 600	O	A	..	D	178	34	68	18000
GA8S	S-M	4	8	8 1/2 x 11	345- 440	450- 600	O	A	TC	D	180	34	68	19000
L8	S-M	4	8	10 x 14	300- 450	350- 514	O	A	..	D	214	42	85	32000
L8S	S-M	4	8	10 x 14	420- 660	350- 514	O	A	TC	D	217	42	85	33500
P8	S-M	4	8	12 x 15	550- 700	400- 514	O	A	..	D	235	46	93	46000
P8S	S-M	4	8	12 x 15	800-1000	400- 514	O	A	TC	D	239	46	93	48000
V8	S-M	4	8	14 x 19	750- 925	325- 400	O	A	..	D	292	57	114	74000
V8S	S-M	4	8	14 x 19	1125-1400	325- 400	O	A	TC	D	296	57	114	76000
Z8	S-M	4	8	16 x 20 1/2	800-1000	240- 300	O	A	..	D	347	62	125	112000
Z8S	S-M	4	8	16 x 20 1/2	1200-1500	240- 300	O	A	TC	D	350	62	125	115000

All engines are 4-cycle, single-acting, vertical and use the exclusive, solid injection type UNION fuel system. Starting is by air at approximately 250 p.s.i pressure. Supercharging is by Buchi turbocharger system.

United States Motors Corporation
Oshkosh, Wisconsin

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. H.P.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Heigth In.	Weight Lb.
2FMB12	M-S	4	1	3 1/2 x 4	3.75	1200	O	H-EL	..	..	37	22	31	675
3FMB18	M-S	4	1	3 1/2 x 4	5.25	1800	O	H-EL	..	..	37	22	31	675
5DAC12	M-S	4	4	3 5/8 x 3 3/4	20	1200	B	EL	..	..	55	26	43	1500
5DAC14	M	4	4	3 5/8 x 3 3/4	22	1400	B	EL	..	..	55	26	43	1500
5DAC18	S	4	4	3 5/8 x 3 3/4	30	1800	B	EL	..	..	55	26	43	1500
705DAC12	M-S	4	4	3 5/8 x 3 3/4	20	1200	B	EL	..	..	59	26	43	1550
704D4D12	M-S	4	4	3 3/4 x 4	26	1200	B	EL	..	..	62	23	43	1600
705DAC14	M	4	4	3 5/8 x 3 3/4	22	1400	B	EL	..	..	59	26	43	1550
705DAC18	M-S	4	4	3 5/8 x 3 3/4	30	1800	B	EL	..	..	59	26	43	1550
10DAC12	M-S	4	4	3 5/8 x 3 3/4	20	1200	B	EL	..	..	60	26	43	1650
10D4D12	M-S	4	4	3 3/4 x 4	26	1200	B	EL	..	..	65	26	43	1700
10DAC14	M	4	4	3 5/8 x 3 3/4	22	1400	B	EL	..	..	60	26	43	....
10DAC18	M-S	4	4	3 5/8 x 3 3/4	30	1800	B	EL	..	..	60	26	43	....
10D4D18	M-S	4	4	3 3/4 x 4	41.5	1800	B	EL	..	..	65	25	43	1700
15DC12	M-S	4	4	4 x 4 1/2	42	1200	B	EL	..	..	70	25	47	....
15DAC18	M-S	4	4	3 5/8 x 3 3/4	30	1800	B	EL	..	..	60	26	43	....
15D4D18	M-S	4	4	3 3/4 x 4	46.5	1800	B	EL	..	..	67	25	43	1800
20DJC12	M-S	4	6	3 3/4 x 4 1/2	47	1200	B	EL	..	..	76	25	43	2400
20D4D18	M-S	4	4	3 3/4 x 4	41.5	1800	B	EL	..	..	69	25	43	2000
25DJH12	M-S	4	6	3 3/4 x 4 1/2	52	1200	B	EL	..	..	88	28	48	2900
25DC18	S	4	4	4 x 4 1/2	55.8	1800	B	EL	..	..	70	25	47	2500
30DWD12	M-S	4	6	4 1/4 x 4 3/4	70	1200	B	EL	..	..	93	31	52	3700
30DJC18	S	4	6	3 3/4 x 4 1/2	69.8	1800	B	EL	..	..	76	25	43	2400
40DRC12	M-S	4	6	4 5/8 x 5 1/4	90	1200	B	EL	..	..	98	34	53	4800
40DJH18*	S	4	6	3 3/4 x 4 1/2	79.8	1800	B	EL	..	..	90	29	48	3500
50DFB12	M-S	4	6	5 x 6	121	1200	B	EL	..	..	110	37	77	6200
50DWD18*	S	4	6	4 1/4 x 4 3/4	107.5	1800	B	EL	..	..	93	31	52	4100
60DFC12	M-S	4	6	5 1/4 x 6	134	1200	B	EL	..	..	112	37	77	6300
60DRC18*	S	4	6	4 5/8 x 5 1/4	130	1800	B	EL	..	..	98	34	53	4800
75DFE12	M-S	4	6	5 5/8 x 6	156	1200	B	EL	..	..	113	33	77	6400
100WKD12	M-S	4	6	6 1/4 x 6 1/2	189	1200	B	EL	..	..	118	44	79	9000
100DFD18*	S	4	6	5 1/2 x 6	204	1800	B	EL	..	..	112	37	77	6700
125DV12	M-S	4	8	6 1/4 x 6	252	1200	B	EL	..	..	114	44	76	11000
140DV12*	S	4	8	6 1/4 x 6	252	1200	B	EL	..	..	117	44	76	11000
200DV18*	S	4	8	6 1/4 x 6	359	1800	B	EL	..	..	120	44	76	11500

*Marine and stationary engine-generator sets. * For emergency or stand-by use only. FMB Models—Fairbanks-Morse engine; DAC and WKD Models—Waukesha engine; All Others—Hercules engine.*

Washington Iron Works
1500 Sixth Avenue, South
Seattle, Washington

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. H.P.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
3-125	M-S	4	3	9 x 12½	90	400	BS	A	..	O	128	37½	82½	13500
4-125	M-S	4	4	9 x 12½	120	400	BS	A	..	O	142	37½	82½	14700
5-125	M-S	4	5	9 x 12½	150	400	BS	A	..	D	137	37½	82½	16500
6-125	M-S	4	6	9 x 12½	200	450	BS	A	..	D	151	37½	82½	18000
6-125TS	M-S	4	6	9 x 12½	285	450	BS	A	TC	D	151	37½	82½	19000
8-125	M-S	4	8	9 x 12½	270	450	BS	A	..	D	181	37½	82½	21000
8-125TS	M-S	4	8	9 x 12½	380	450	BS	A	TC	D	181	37½	82½	22000
3-13	M-S	4	3	10¼ x 13½	120	360	BS	A	..	O	136	40	89	15800
4-13	M-S	4	4	10¼ x 13½	160	360	BS	A	..	O	158	40	89	18500
6-13	M-S	4	6	10¼ x 13½	260	390	BS	A	..	D	166	40	89	23000
6-13TS	M-S	4	6	10¼ x 13½	345	390	BS	A	TC	D	166	40	89	24000
8-13	M-S	4	8	10¼ x 13½	350	390	BS	A	..	D	202	40	89	26500
8-13TS	M-S	4	8	10¼ x 13½	460	390	BS	A	TC	D	202	40	89	27500
4-15	M-S	4	4	11½ x 15	200	327	BS	A	..	D	169	46	100	27000
6-15	M-S	4	6	11½ x 15	330	360	BS	A	..	D	189	46	100	31500
6-15TS	M-S	4	6	11½ x 15	450	360	BS	A	TC	D	189	46	100	33000
8-15	M-S	4	8	11½ x 15	440	360	BS	A	..	D	233	46	100	40500
8-15TS	M-S	4	8	11½ x 15	600	360	BS	A	TC	D	233	46	100	43000
6-160	M-S	4	6	12¾ x 16	400	360	BS	A	..	D	209	50	106½	42000
6-160TS	M-S	4	6	12¾ x 16	585	360	BS	A	TC	D	209	50	106½	44000
8-160	M-S	4	8	12¾ x 16	550	360	BS	A	..	D	249	50	106½	53000
8-160TS	M-S	4	8	12¾ x 16	780	360	BS	A	TC	D	294	50	106½	55000
6-18	M-S	4	6	14½ x 18	500	300	BS	A	..	D	245	56	120½	62500
6-18TS	M-S	4	6	14½ x 18	710	300	BS	A	TC	D	245	56	120½	65000
8-18	M-S	4	8	14½ x 18	665	300	BS	A	..	D	292	56	120½	80000
8-18TS	M-S	4	8	14½ x 18	945	300	BS	A	TC	D	292	56	120½	82500
6-20	M-S	4	6	16 x 20	640	277	BS	A	..	D	264	61	133	82000
6-20TS	M-S	4	6	16 x 20	885	277	BS	A	TC	D	264	61	133	85000
8-20	M-S	4	8	16 x 20	850	277	BS	A	..	D	321	61	133	103000
8-20TS	M-S	4	8	16 x 20	1180	277	BS	A	TC	D	321	61	133	106000

Engines have open combustion chamber. All are for both marine and stationary use. Lengths and weights are for marine engines. All marine models are direct reversing except 3 and 4-cyl. units which have reverse gear.

Waukesha Motor Company
Waukesha, Wisc.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
180-DAC	S-P	4	4	3 5/16 x 3¾	35	2400	B	H-EL	..	..	31	19	28	475
180-DLC	S-P	4	4	3½ x 3¾	45	2400	B	H-EL	..	..	31	19	28	475
185-DAC	S-P	4	6	3 5/16 x 3¾	51	2200	B	EL	..	..				
190-DLC	S-P	4	6	3¾ x 4	76	2400	B	H-EL	..	..	42¾	22	29 1/16	868
190-DLCA	S-P	4	6	3¾ x 4	84	2800	B	H-EL	..	..	42½	22	29	868
195-DLC	S-P	4	6	4 x 4	96	2400	B	H-EL	..	..	43	26	30	965
195-DLCA	S-P	4	6	4 x 4	98	2800	B	H-EL	..	..	43	26	30	965
135-DK	S-P	4	6	4¼ x 5	140	2400	B	EL	..	..	47½	26	34½	1386
135-DKB	S-P	4	6	4¼ x 5	147	2800	B	EL	..	..	47½	26	34½	1386
135-DKBS	S-P	4	6	4¼ x 5	185	2800	B	EL	TC	..	47½	26	41	1486
148-DK	S-P	4	6	5¼ x 6	197	2000	B	EL-G	..	..	56	28½	47	2320
148-DKB	S-P	4	6	5¼ x 6	200	2100	B	EL-G	..	..	56	28½	47	2320
148-DKBS	S-P	4	6	5¼ x 6	280	2100	B	EL-G	..	..	56	28½	55½	2445
WAKD	S-P	4	6	6¼ x 6½	224	1600	B	EL-G	..	..	66½	33	51	3800
WAKDS	S-P	4	6	6¼ x 6½	352	1800	B	EL-G	TC	..	66½	33	62½	3925
NKD	S-P	4	6	7 x 8¼	269	1050	B	G	..	..	79	48	60½	9285
NKDS	S-P	4	6	7 x 8¼	380	1200	B	G	TC	..	79	48	60½	9435
LRD	S-P	4	6	8½ x 8½	392	1100	B	G	..	..	97½	49	69½	10300
LRDS	S-P	4	6	8½ x 8½	570	1200	B	G	TC	..	113½	49	69½	10450

White-Roth Machine Corp.
Lorain, Ohio

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. H.P.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
LD	S	2	1	7 5/16 x 8	22	600	B-BS	G	..	..	72	48	53	2600
OD	S	2	1	9 5/16 x 10	33	450	B-BS	G	..	..	88	58	59	3630
AD	S	2	1	13 x 13	57	325	B-BS	G	..	..	110	74	68	8300

Witte Engine Works
Oil Well Supply Division, U. S. Steel Corporation
Kansas City, Missouri

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
AD	S-P	4	1	3 1/16 x 4½	4-6.8	1200-1800	DM-B	H-EL	..	..	23½	23½	32¾	450
BD	S-P	4	1	4¼ x 6	8	900	DM-B	H	..	..	45½	33 1/16	27¾	930
LD	S-P	4	1	4¾ x 5¼	9	1350	DM-B	H-EL	..	..	28⅞	28	43½	842
CD	S-P	4	1	5 x 8	12.5	750	B	H	..	..	52¾	36	36¾	1352

All engines have pre-combustion chambers. Designations indicate a series built in several different models determined by type of cooling equipment and power take-off.

Wolverine Motor Works, Inc.
Bridgeport, Conn.

Model	Use	Cycle	No. of Cyl.	Bore & Stroke In.	Cont. H.P.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
....	M	2	2	6⅛ x 8¼	25- 30	425-500	BS	A	..	O	79¾	..	..	4035
....	M	2	3	6⅛ x 8¼	38- 45	425-500	BS	A	..	O	92⅝	..	..	4975
....	M	2	4	6⅛ x 8¼	50- 60	425-500	BS	A	..	O	105½	..	..	6000

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weigh Lb.
....	M	2	6	6⅝ x 8⅝	75- 90	425-500	BS	A	..	D	112	..	..	7200
....	M-S	4	3	8½ x 10½	110-120	600-650	BS	A	..	S	97	..	..	8300
....	M-S	4	4	8½ x 10½	145-160	600-650	BS	A	..	S	110	..	..	9500
....	M-S	4	5	8½ x 10½	185-200	600-650	BS	A	..	S	124	..	..	10400
....	M-S	4	6	8½ x 10½	225-240	600-650	BS	A	..	S	137	..	..	11600
....	M-S	4	8	8½ x 10½	300-320	600-650	BS	A	..	S	180*	..	..	13800
....	M-S	4	3	8½ x 12½	75- 90	360-400	O	A	..	O	117	..	..	11300
....	M-S	4	4	8½ x 12½	100-120	360-400	O	A	..	O	133⅝	..	..	12000
....	M-S	4	4	8¾ x 13	120-140	360-400	O	A	..	O	143⅛	..	..	13500
....	M	4	4	9¼ x 14	140-160	360-400	O	A	..	O	146½	..	..	15000
....	M	4	5	9¼ x 14	175-200	360-400	O	A	..	D	127¼	..	..	18500
....	M	4	6	9¼ x 14	210-240	360-400	O	A	..	D	143⅝	..	..	19000
....	M	4	8	9¼ x 14	280-320	360-400	O	A	..	D	176	..	..	24000

*With reverse and 2 to 1 reduction gear.

Worthington Corporation
Harrison, New Jersey

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weigh t Lb.
BB5	S-P	4	5	8 x 10½	150	600	..	A	..	..	..	..	..	....
BB6	S-P	4	6	8 x 10½	180	600	..	A	..	..	..	..	..	....
CC5	S-P	4	5	10¾ x 14½	345	514	..	A	..	..	..	..	..	....
CC6	S-P	4	6	10¾ x 14½	410	514	..	A	..	..	..	..	..	....
CC7	S-P	4	7	10¾ x 14½	480	514	..	A	..	..	..	..	..	....
CC8	S-P	4	8	10¾ x 14½	550	514	..	A	..	..	..	..	..	....
SCC5	S-P	4	5	10¾ x 14½	515	514	..	A	TC	..	..	..	..	....
SCC6	S-P	4	6	10¾ x 14½	615	514	..	A	TC	..	..	..	..	....
SCC7	S-P	4	7	10¾ x 14½	720	514	..	A	TC	..	..	..	..	....
SCC8	S-P	4	8	10¾ x 14½	825	514	..	A	TC	..	..	..	..	....
DD5	S	4	5	13¼ x 17½	435	360	..	A	..	..	..	..	..	....
DD6	S	4	6	13¼ x 17½	525	360	..	A	..	..	..	..	..	....
DD7	S	4	7	13¼ x 17½	615	360	..	A	..	..	..	..	..	....
DD8	S	4	8	13¼ x 17½	700	360	..	A	..	..	..	..	..	....
SDD5	S	4	5	13¼ x 17½	660	360	..	A	TC	..	..	..	..	....
SDD6	S	4	6	13¼ x 17½	790	360	..	A	TC	..	..	..	..	....
SDD7	S	4	7	13¼ x 17½	925	360	..	A	TC	..	..	..	..	....
SDD8	S	4	8	13¼ x 17½	1055	360	..	A	TC	..	..	..	..	....
DH5	S-P	4	5	12 x 14	480	600	..	A	..	..	..	..	..	....
DH6	S-P	4	6	12 x 14	575	600	..	A	..	..	..	..	..	....
DH8	S-P	4	8	12 x 14	765	600	..	A	..	..	..	..	..	....
SDH5	S-P	4	5	12 x 14	845	600	..	A	TC	..	..	..	..	....
SDH6	S-P	4	6	12 x 14	1015	600	..	A	TC	..	..	..	..	....
SDH8	S-P	4	8	12 x 14	1350	600	..	A	TC	..	..	..	..	....
DR5	S	4	5	13¼ x 17½	550	450	..	A	..	..	..	..	..	....
DR6	S	4	6	13¼ x 17½	660	450	..	A	..	..	..	..	..	....
DR7	S	4	7	13¼ x 17½	770	450	..	A	..	..	..	..	..	....
DR8	S	4	8	13¼ x 17½	880	450	..	A	..	..	..	..	..	....
SDR5	S	4	5	13¼ x 17½	965	450	..	A	TC	..	..	..	..	....
SDR6	S	4	6	13¼ x 17½	1160	450	..	A	TC	..	..	..	..	....
SDR7	S	4	7	13¼ x 17½	1355	450	..	A	TC	..	..	..	..	....
SDR8	S	4	8	13¼ x 17½	1545	450	..	A	TC	..	..	..	..	....
EH5	S	4	5	16 x 20	730	360	..	A	..	..	..	..	..	....
EH6	S	4	6	16 x 20	880	360	..	A	..	..	..	..	..	....
EH7	S	4	7	16 x 20	1025	360	..	A	..	..	..	..	..	....
EH8	S	4	8	16 x 20	1170	360	..	A	..	..	..	..	..	....
SEH5	S	4	5	16 x 20	1255	360	..	A	TC	..	..	..	..	....
SEH6	S	4	6	16 x 20	1515	360	..	A	TC	..	..	..	..	....
SEH7	S	4	7	16 x 20	1760	360	..	A	TC	..	..	..	..	....
SEH8	S	4	8	16 x 20	2010	360	..	A	TC	..	..	..	..	....

*Dual-fuel diesels and spark ignition gas engines are available in similar sizes. All ratings are for 60-cycle speeds. * Current ratings—consult engine division for increased ratings.*

Imported Diesels

Brush Aboe, Inc.
Empire State Building
350 Fifth Avenue
New York 1, N. Y.

Model		Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
Petter	AVA1	SP	4	1	3.15 x 4.33	5¼	1800	Bryce	EL-H	..	..	29¼	21	30	390
"	AVA2	SP	4	2	3.15 x 4.33	10½	1800	"	EL-H	..	..	36½	21	31⅜	558
"	AV1	SP	4	1	3.15 x 4.33	6	1800	"	EL-H	..	..	29⅝	20⅛	29¼	406
"	AV2	SP	4	2	3.15 x 4.33	12	1800	"	EL-H	..	..	36½	20⅝	31⅝	598
"	B2T	S-P-M	4	2	4.33 x 4.33	20	1500	"	EL-H	..	..	32½	24⅛	33	1198
"	B3T	S-P-M	4	3	4.33 x 4.33	30	1500	"	EL-H	..	..	39¼	24⅛	33	1477
"	B4T	S-P-M	4	4	4.33 x 4.33	40	1500	"	EL-H	..	..	45¾	24⅛	33	1737
Meadows	4DC-330	S-P	4	4	4.724 x 4.724	60	1800	Cav	EL	..	..	38	22½	40	950
"	4DC-420	S-P	4	4	5⅛ x 5⅛	66	1600	"	EL	..	..	42⅛	31⅝	43½	1500
"	4DC-630	S-P	4	6	5⅛ x 5⅛	100	1600	"	EL	..	..	52½	50⅝	41⅝	1790
"	Greenville	M	4	4	5½ x 5½	65	1650	"	EL	..	..	70½	35	47	2200
"	Frobisher	M	4	6	5½ x 5½	100	1650	"	EL	..	..	82⅝	35	47	2550
Petter	AV2M	M	4	2	3.15 x 4.33	10	1500	Bryce	EL-H	..	..	48	20	29¼	760
Meadows	970	S-P	4	6	5.9 x 5.9	150	1500	Cav	EL	..	..	63⅝	32½	47½	3500
"	970S	S-P-M	4	6	5.9 x 5.9	200	1500	"	EL	T-C	..	68	32½	47½	3900
Mirrlees	J6	S-M	4	6	9¾ x 10½	360	720	Bryce	A	T-C	..	..	..	..	.....
"	JS8	S-M	4	8	9¾ x 10½	665	720	"	A	..	..	..	..	..	.....
"	JV12	S-M	4	12	9¾ x 10½	724	720	"	A	..	..	..	..	..	.....
"	JSV16	S-M	4	16	9¾ x 10½	1310	720	"	A	T-C	..	..	..	..	.....
"	K8	S-M	4	8	15 x 18	990	428	"	A	..	..	..	..	..	.....
"	KVS12	S-M	4	12	15 x 18	2160	428	"	A	T-C	..	..	..	..	.....
National	M4AS	S-M	4	8	6 x 8½	198	1000	Cav	A-EL	..	..	96⅛	36	57⅜	7160
"	R4AU6	S-M	4	6	9 x 12	405	600	"	A	T-C	..	127	54⅝	81⅞	18060
"	F4AU8	S-M	4	8	12 x 15	1040	500	"	A	T-C	..	215	85	103	56000
"	B4AU8	S-M	4	8	17 x 21½	1728	333	"	A	T-C	..	298	106	135	133880
Vivian	M4AU8	S-M	4	8	6 x 8½	360	1200	"	A-EL	..	..	120	34	57	7000

The above list is only representative of the sizes and types that Brush Aboe, Inc. manufacture; engines up to 3000 hp. are available.

Bolinders Company, Inc.
33 Rector Street
New York 6, N. Y.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
W3M15	M	2	1	4¾ x 4¾	8–10	900	O	A-EL	..	G	37	..	..	415
W3M25	M	2	2	4¾ x 4¾	16–20	900	O	A-EL	..	G	44⅞	..	..	930
W7M15	M	2	1	7⅛ x 7⅛	25	800	O	A-EL	..	G	43⅝	..	..	1525
W7M25	M	2	2	7⅛ x 7⅛	50	800	O	A-EL	..	G	49⅝	..	..	1985
W7M45	M	2	4	7⅛ x 7⅛	100	800	O	A-EL	..	G	86⅝	..	..	3300
M42EB	M	2	2	....	80– 100	450– 600	O	A	..	O	100	..	..	8250
M43EB	M	2	3	....	120– 155	450– 600	O	A	..	O	121	..	..	10500
M44EB	M	2	4	....	160– 210	450– 600	O	A	..	O	141	..	..	128000
M45EB	M	2	5	....	200– 265	450– 600	O	A	..	O	155	..	..	1480
M46EB	M	2	6	....	240– 320	450– 600	O	A	..	O	166	..	..	17200
M44E	M	2	4	....	160– 210	450– 600	O	A	..	D	104	..	..	11700
M45E	M	2	5	....	200– 265	450– 600	O	A	..	D	117	..	..	13500
M46E	M	2	6	....	240– 320	450– 600	O	A	..	D	129	..	..	15100
M47E	M	2	7	....	280– 375	450– 600	O	A	..	D	145	..	..	16500
M44I	M	2	4	....	300– 420	300– 425	O	A	..	D	163	..	..	32200
M45I	M	2	5	....	370– 520	300– 425	O	A	..	D	185	..	..	36600
M46I	M	2	6	....	450– 630	300– 425	O	A	..	D	203	..	..	40000
M47I	M	2	7	....	520– 730	300– 425	O	A	..	D	232	..	..	46300
M33M	M	2	4	....	560– 730	220– 300	O	A	..	D	215	..	..	64600
M45M	M	2	5	....	700– 910	220– 300	O	A	..	D	246	..	..	78200
M46M	M	2	6	....	840–1100	220– 300	O	A	..	D	274	..	..	84800
M47M	M	2	7	....	980–1280	220– 300	O	A	..	D	312	..	..	99000
M48M	M	2	8	....	1120–1460	220– 300	O	A	..	D	343	..	..	109000

M models have open type combustion chambers. Weight for MEB models include reverse gear. Models W3 and 7 are surface ingition engines of Bolinder manufacture. Balance are of Atlas Polar design sold through Bolinders.

Burmeister & Wain American Corporation
17 Battery Place
New York 4, N. Y.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
450-VT-110	M-S	2	4	19.7 x 43.3	1680	170	O	A	..	D	..	..	..	....
550-VT-110	M-S	2	5	19.7 x 43.3	2100	170	O	A	..	D	..	..	..	....
650-VT-110	M-S	2	6	19.7 x 43.3	2520	170	O	A	..	D	..	..	..	....
750-VT-110	M-S	2	7	19.7 x 43.3	2940	170	O	A	..	D	..	..	..	....
850-VT-110	M-S	2	8	19.7 x 43.3	3360	170	O	A	..	D	..	..	..	....
950-VT-110	M-S	2	9	19.7 x 43.3	3780	170	O	A	..	D	..	..	..	....
1050-VT-110	M-S	2	10	19.7 x 43.3	4200	170	O	A	..	D	..	..	..	....
1150-VT-110	M-S	2	11	19.7 x 43.3	4620	170	O	A	..	D	..	..	..	....
1250-VT-110	M-S	2	12	19.7 x 43.3	5040	170	O	A	..	D	..	..	..	....
462-VT-115	M-S	2	4	24.4 x 45.3	2400	150	O	A	..	D	..	..	..	....
562-VT-115	M-S	2	5	24.4 x 45.3	3000	150	O	A	..	D	..	..	..	....
662-VT-115	M-S	2	6	24.4 x 45.3	3600	150	O	A	..	D	..	..	..	....
762-VT-115	M-	2	7	24.4 x 45.3	4200	150	O	A	..	D	..	..	..	....
862-VT-115	M-S	2	8	24.4 x 45.3	4800	150	O	A	..	D	..	..	..	....
962-VT-115	M-S	2	9	24.4 x 45.3	5400	150	O	A	..	D	..	..	..	....
1062-VT-115	M-S	2	10	24.4 x 45.3	6000	150	O	A	..	D	..	..	..	....
1162-VT-115	M-S	2	11	24.4 x 45.3	6600	150	O	A	..	D	..	..	..	....
1262-VT-115	M-S	2	12	24.4 x 45.3	7200	150	O	A	..	D	..	..	..	....
474-VT-140	M-S	2	4	29.1 x 55.1	3500	125	O	A	..	D	..	..	..	....
574-VT-140	M-S	2	5	29.1 x 55.1	4375	125	O	A	..	D	..	..	..	....
674-VT-140	M-S	2	6	29.1 x 55.1	5250	125	O	A	..	D	..	..	..	....
774-VT-140	M-S	2	7	29.1 x 55.1	6125	125	O	A	..	D	..	..	..	....
874-VT-140	M-S	2	8	29.1 x 55.1	7000	125	O	A	..	D	..	..	..	....
974-VT-140	M-S	2	9	29.1 x 55.1	7875	125	O	A	..	D	..	..	..	....
1074-VT-140	M-S	2	10	29.1 x 55.1	8750	125	O	A	..	D	..	..	..	....
1174-VT-140	M-S	2	11	29.1 x 55.1	9625	125	O	A	..	D	..	..	..	....
1274-VT-140	M-S	2	12	29.1 x 55.1	10500	125	O	A	..	D	..	..	..	....

Not listed are various types of 4-cycle, 2-cycle and 2-cycle double acting engines. Inclusion of "S" in designation indicates stationary model; "P" indicates marine.

Crofton Industrial Diesel Engines
San Diego 1, California

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
4-1A	..	4	1	3⅛ x 3⅛	4	1500	B	H-EL	..	..	28*	19	27½	235
5-1W	M-S	4	1	3⅛ x 3⅛	5-7	1500	B	H-EL	..	..	38¼	17⅝	26⅝	246
7-1W	M-S	4	1	3⅛ x 3⅛	7-9	1500	B	H-EL	..	..	38¼	17⅝	26⅝	266
9-1W	M-S	4	1	3⅛ x 3⅛	9-11	1500	B	H-EL	..	..	38¼	17⅝	26⅝	275

** Includes starting handle. Ricardo type precombustion system is used.*

Klockner-Humboldt-Deutz
Diesel Energy Corporation
47 West Street
New York 6, N.Y.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
MAH711	S-P-M	4	1	3⅛ x 4⅜	6.0	1500	O	H	..	..	31½	22½	34½	375
MAH914	S-P-M	4	1	3⅛ x 5½	11	1500	O	H	..	..	40½	28½	29	693
MAH916	S-P-M	4	1	4¾ x 6⅝	16	1300	O	H	..	..	45½	33	31	965
MAH220	S-P	4	1	5⅞ x 7⅞	22	1000	O	H-A	..	..	52½	37	35	1698
A1L514*	S-P-M	4	1	4⅝ x 5½	12.5	1500	O	H-EL	..	..	22	23½	40	728
A2L514*	S-P-M	4	2	4⅝ x 5½	25	1500	O	H-EL	..	..	27	27	37½	915

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. H.P.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
A3L514*	S-P-M	4	3	4⅜ x 5½	37.5	1500	O	H-EL	..	..	30	26	37½	1014
A4L514*	S-P-M	4	4	4⅜ x 5½	60	1800	B	EL	..	..	44	29	41	1213
A6L514*	S-P-M	4	6	4⅜ x 5½	90	1800	B	EL	..	..	54	33	40	1610
A6L614*	S-P	4	6V	4⅜ x 5½	90	1800	B	EL	..	..	44	47	36	1670
A8L614*	S-P-M	4	8V	4⅜ x 5½	120	1800	B	EL	..	..	47	47	36	1930
F1L514*	P	4	1	4⅜ x 5½	15	1650	O	H-EL	..	..	22	23½	40	728
F2L514*	P	4	2	4⅜ x 5½	30	1600	O	H-EL	..	..	27	27	37½	850
F3L514*	P	4	3	4⅜ x 5½	45	1600	O	H-EL	..	..	30	26	37½	945
F4L514*	Truck	4	4	4⅜ x 5½	82–90	2300	B	EL	..	..	44	29	41	1043
F6L514*	Truck	4	6	4⅜ x 5½	120–130	2250	B	EL	..	..	54	33	40	1373
F6L614*	Truck	4	6V	4⅜ x 5½	120–130	2250	B	EL	..	..	44	47	36	1595
F8L614*	Truck	4	8V	4⅜ x 5½	160–175	2250	B	EL	..	..	47	47	36	1870
T2M425	S-P-M	2	2	5⅞ x 9⅛	52	600	O	A	..	..	51	36	57	4190
T3M425	S-P-M	2	3	5⅞ x 9⅛	80	600	O	A	..	..	61	36	57	5180
T4M425	S-P-M	2	4	5⅞ x 9⅛	105	600	O	A	..	..	71	36	57	6173
T4M525	S-P-M	2	4V	7⅛ x 9⅛	210	600	O	A	..	D	61	59	57	5070
T8M525	S-P-M	2	8V	7⅛ x 9⅛	420	600	O	A	..	D	81½	59	57	8050
T4M233	S-P-M	2	4	8⅝ x 13	250	500	B	A	..	D	103	47	73	10900
T8M233	S-P-M	2	8V	8⅝ x 13	500	500	B	A	..	D	110	63	77	15540

Sulzer Bros. Ltd., New York
50 Church Street
New York 7, N. Y.

Model	Use	Cycle	No. Cyl.	Bore & Stroke In.	Cont. HP.	Cont. R.P.M.	Fuel System	Start	Super-Charge	Rev. Gear	Length In.	Width In.	Height In.	Weight Lb.
3BA22	S	4	3	8.67 x 12.6	210	600	O	A	TC	..	..	..	..	...
4BA22	S	4	4	8.67 x 12.6	275	600	O	A	TC	..	..	..	..	...
5BA22	S	4	5	8.67 x 12.6	350	600	O	A	TC	..	..	..	..	...
6BA22	S	4	6	8.67 x 12.6	450	600	O	A	TC	..	..	..	..	...
8BA22	S	4	8	8.67 x 12.6	600	600	O	A	TC	..	..	..	..	...
6BA29	S	4	6	11.4 x 14.4	700	500	O	A	TC	..	..	..	..	...
7BA29	S	4	7	11.4 x 14.4	800	500	O	A	TC	..	..	..	..	...
8BA29	S	4	8	11.4 x 14.4	950	500	O	A	TC	..	..	..	..	...
4T36	S	2	4	14.4 x 23.6	800	300	O	A	..	..	..	..	..	...
5T36	S	2	5	14.4 x 23.6	1000	300	O	A	..	..	..	..	..	...
6T36	S	2	6	14.4 x 23.6	1200	300	O	A	..	..	..	..	..	...
8T36	S	2	8	14.4 x 23.6	1600	300	O	A	..	..	..	..	..	...
4TPF48	S	2	4	18.9 x 27.5	1400	250	O	A	..	..	..	..	..	...
5TPF48	S	2	5	18.9 x 27.5	1750	250	O	A	..	..	..	..	..	...
6TPF48	S	2	6	18.9 x 27.5	2100	250	O	A	..	..	..	..	..	...
7TPF48	S	2	7	18.9 x 27.5	2450	250	O	A	..	..	..	..	..	...
8TPF48	S	2	8	18.9 x 27.5	2800	250	O	A	..	..	..	..	..	...
10TPF48	S	2	10	18.9 x 27.5	3500	250	O	A	..	..	..	..	..	...
12TPF48	S	2	12	18.9 x 27.5	4200	250	O	A	..	..	..	..	..	...
6SF72	S	2	6	28.3 x 35.4	4500	187	O	A	..	..	..	..	..	...
8SF72	S	2	8	28.3 x 35.4	6000	187	O	A	..	..	..	..	..	...
10SF72	S	2	10	28.3 x 35.4	7500	187	O	A	..	..	..	..	..	...
12SF72	S	2	12	28.3 x 35.4	9000	187	O	A	..	..	..	..	..	...
4TW24	M	2	4	9.46 x 15.75	300	400	O	A	..	G	..	..	..	...
6TW24	M	2	6	9.46 x 15.75	450	400	O	A	..	G	..	..	..	...
6TD24	M	2	6	9.46 x 15.75	450	400	O	A	..	..	..	..	..	...
6TD29	M	2	6	11.4 x 19.75	600	300	O	A	..	..	..	..	..	..
7TD29	M	2	7	11.4 x 19.75	700	300	O	A	..	..	..	..	..	...
8TD29	M	2	8	11.4 x 19.75	800	300	O	A	..	..	..	..	..	...
9TD29	M	2	9	11.4 x 19.75	900	300	O	A	..	..	..	..	..	...
5TD36	M	2	5	14.4 x 23.6	750	250	O	A	..	..	..	..	..	...
6TD36	M	2	6	14.4 x 23.6	900	250	O	A	..	..	..	..	..	...
7TD36	M	2	7	14.4 x 23.6	1050	250	O	A	..	..	..	..	..	...
8TD36	M	2	8	14.4 x 23.6	1200	250	O	A	..	..	..	..	..	...
10TD36	M	2	10	14.4 x 23.6	1500	250	O	A	..	..	..	..	..	...
5TPD48	M	2	5	18.9 x 27.5	1500	225	O	A	..	..	..	..	..	...
6TPD48	M	2	6	18.9 x 27.5	1800	225	O	A	..	..	..	..	..	...
10TPD48	M	2	10	18.9 x 27.5	3000	225	O	A	..	..	..	..	..	...
12TPD48	M	2	12	18.9 x 27.5	3600	225	O	A	..	..	..	..	..	...
6SD60	M	2	6	23.6 x 41	3000	150	O	A	..	..	..	..	..	...
7SD60	M	2	7	26.6 x 41	3500	150	O	A	..	..	..	..	..	...
8SD60	M	2	8	23.6 x 41	4000	150	O	A	..	..	..	..	..	...
9SD60	M	2	9	23.6 x 41	4500	150	O	A	..	..	..	..	..	...
10SD60	M	2	10	23.6 x 41	5000	150	O	A	..	..	..	..	..	...
6SD72	M	2	6	28.3 x 49.3	4200	125	O	A	..	..	..	..	..	...
7SD72	M	2	7	28.3 x 49.3	4900	125	O	A	..	..	..	..	..	...
8SD72	M	2	8	28.3 x 49.3	5600	125	O	A	..	..	..	..	..	...
9SD72	M	2	9	28.3 x 49.3	6300	125	O	A	..	..	..	..	..	...
10SD72	M	2	10	28.3 x 49.3	7000	125	O	A	..	..	..	..	..	...
11SD72	M	2	11	28.3 x 49.3	7700	125	O	A	..	..	..	..	..	...
12SD72	M	2	12	28.3 x 49.3	8400	125	O	A	..	..	..	..	..	...
6LDA19	P	4	6	7.5 x ...	420	1100	O	EL	TC	..	..	..	..	...
6LDA22	P	4	6	8.67 x ...	570	950	O	EL	TC	..	..	..	..	...
6LDA25	P	4	6	9.85 x ...	735	850	O	EL	TC	..	..	..	..	...
8LDA25	P	4	8	9.85 x ...	960	850	O	EL	TC	..	..	..	..	...
6LDA28	P	4	6	11.0 x ...	915	750	O	EL	TC	..	..	..	..	...
8LDA28	P	4	8	11.0 x ...	1200	750	O	EL	TC	..	..	..	..	...
12LDA31	P	4	12	12.3 x ...	2250	935‡	O	EL	TC	..	..	..	..	...

‡—*Number of R.P.M. of the generator.*

Photo courtesy Baltimore and Ohio Railorad

B & O chemist R. N. Fracalossi preparing a stick lubricant of molybdenum disulfide and a suitable binder, for use in a wheel flange lubricator.

Molybdenum Disulfide as a Lubricant

High purity molybdenite concentrates offer important characteristics for certain solid-film lubrication applications.

During the last five years, developments have brought forward a material suitable for solid-film lubrication in numerous applications. This material is molybdenum disulfide, the natural form in which molybdenum occurs in nature. While molybdenum is widely used in iron, steel, and chemical industries, its use as a lubricant is relatively new.

This material (MoS_2), in its native state, is found in rock formations, over 85 per cent of the known occurrence being in the United States. The amount of MoS_2 recovered is normally less than 0.05 per cent of the ore. After many crushing, grinding, and refining processes, the molybdenum disulfide is produced in a form suitable for application as a lubricant.

The Climax Molybdenum Company, who supplied considerable of the material on which this article is based, produces the material in two grades. Grade No. 1 is a high-grade molybdenite concentrate produced by oil flotation and contains from 3 to 5 per cent oil, and water up to 15 per cent. Grade No. 2 is produced from Grade No. 1 by reducing the mineral oil to 0.3 per cent, and water to 0.2 per cent. It consists of about 99 per cent MoS_2. Purity is very important since the common impurities are by nature abrasive.

Climax's material in powder form is given the trade name of *Moly-sulphide*. In addition, lubricants containing *Moly-sulphide* are now being offered by some 25 companies throughout the United States in one or more forms. It may be in the form of a dry powder or compounded with oil grease, synthetic lubricant, volatile vehicle, resin, or other carrier.

Characteristics

Molybdenum disulfide has been proven in service to be an effective lubricant under operating conditions where other lubricants have failed. It is well-suited for prevention of galling and seizing even of the softest metals. In addition its main uses are: as an aid in the assembly and disassembly of close-fitting parts; as a lubricant in the hot and cold working and forming of metals; as a lubricant for parts which must function properly at high and low temperatures; as a no-dust-collecting lubricant; and, as a dielectric lubricant.

Many experts think the lubricating properties of MoS_2 are the result of its laminar-type crystal structure, where each layer of molybdenum atoms is sandwiched between two layers of sulfur atoms. According to this idea, the layer of sulfur atoms adheres tightly to metals upon contact because sulfur has a strong affinity for them.

On the other hand, the bond between two layers of sulfur atoms is weak so they slip easily over one another when load is applied. Unlike graphite, the lubricating action of the material does not depend on the presence of a film of moisture, therefore it is satisfactory in applications where moisture is absent, as in a vacuum. Also, it can be used as a lubricant where a non-conducting material is necessary in contrast to the case with graphite.

In comparison with other lubricants for similar applications, molybdenum disulfide has good chemical and thermal stability. It does not attack metals as do lubricating media having large amounts of free sulfur. Under some conditions, coating of this material may give some protection against corrosion. It has been used successfully to retard fretting corrosion.

Molybdenum disulfide coatings have proved unique in some cases involving liquids since the adherent MoS_2 has not washed away, thereby providing long-term lubrication. The lubricating action of dry molybdenum disulfide appears to be unaffected by temperatures from about minus 40°F to plus 700°F. Above 750°F, oxidation occurs in air. In the absence of oxidizing conditions it is stable at much higher temperatures.

Many of the qualities of the material as outlined above were determined and definitely substantiated by investigations and tests made and reported in detail by such well-know and reliable organizations as National Advisory

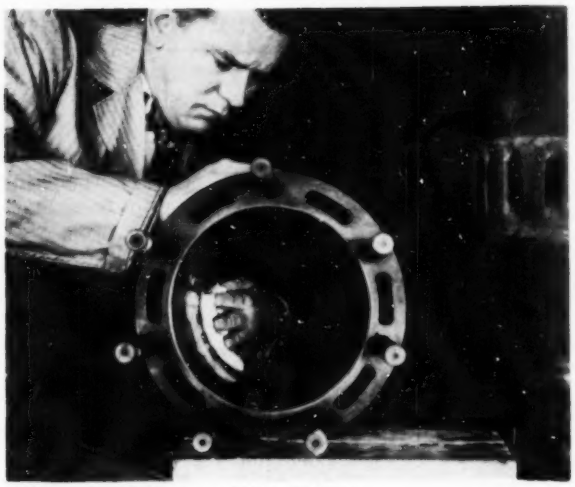


Photo courtesy Baltimore and Ohio Railroad

Above, molybdenum disulfide in powder form is being rubbed onto the clean working surface of a diesel cylinder liner.

Photo courtesy Baltimore and Ohio Railroad

B & O's Supervisor of Lubrication, Mr. E. A. Compney inspecting a lubricator which applies molybdenum disulfide to wheel flanges.

Committee For Aeronautics, in various Technical Notes; Journal of Research of The National Bureau of Standards; in Research, published by Butterworths Scientific Publications, Ltd., London, England; and, ASME Transactions.

Some Findings

In Technical Note No. 1578 of National Advisory Committee For Aeronautics, Summary, it is stated, "An experimental investigation was conducted to identify the roles of solid-surface films in the various mechanisms of sliding and lubrication involved in the mating and compatibility of boundary-lubricated slider surfaces, in the action of extreme-pressure lubricants, and in the operation of slider surfaces not supplied with fluid lubricants.

"A solid film of molybdenum disulfide (MoS_2) was very effective in reducing friction at high sliding velocities. The film was very easily applied, was very tenacious, was chemically and thermally stable, and consequently could have many practical applications. The molybdenum disulfide has a laminar structure similar to graphite, and because of its tenaciousness was more satisfactory than graphite as a solid film lubricant at high sliding velocities."

In Technical Note No. 1882, Summary reads, "An experimental investigation was conducted to determine the oxidation characteristics of molybdenum disulfide (MoS_2) and to determine the affect of such oxidation on its role as a slid-film lubricant.

"A coating of molybdenum disulfide, serving as a high-temperature solid-film lubricant, maintained low coefficient-of-friction values during its oxidation as long as an effective subfilm of the molybdenum disulfide remained. Films of the oxidation product of molybdenum disulfide, namely molybdenum trioxide, alone produced high friction. Molybdenum disulfide began to oxidize at a very low rate when heated in air at 750°F, the rate increasing steadily and becoming high at 1050°F and above. Molybdenum disulfide maintained its original hexagonal structure when heated to 1000°F in vacuum."

In Technical Note No. 2027 on "Friction and Wear of Hot-Pressed Bearing Materials Containing Molybdenum Disulfide," Summary, it is stated, "An experimental investigation was conducted to determine the feasibility of bearing lubrication by a process involving the transfer of molybdenum disulfide from within the structure of a composite bearing material to the interface between the contacting surfaces. The investigation was also conducted to establish the proportionate amount of lubricant necessary in such a bearing metal. A study was made of bearing materials composed of various amounts of molybdenum disulfide (up to 35 per cent), silver, and 5 per cent copper.

"The materials investigated were lubricated by a transfer of solid lubricant MoS_2 from within the surface of the rider to the interface between rider and slider. This transfer resulted in the formation of an effective lubricating film. The best composition studied in this investigation, from considerations of both wear and friction, contained 10 per cent molybdenum disulfide. This composition showed the lowest rate of wear and relatively low friction (approaching the lowest obtained); the friction for this material was relatively unaffected by sliding velocity. Surface welding occurred with specimens containing less than 5 per cent molybdenum disulfide."

In Summary of Excerpts from Technical Note No. 2180, it is stated, "The effectiveness of MoS_2 as a fretting-corrosion inhibitor was investigated. Six methods of applying MoS_2 to steel specimens were evaluated by noting the number of cycles of vibration required to produce the first evidence of fretting corrosion and by observing the nature of its occurrence.

"A coating of dry MoS_2 (bonded to steel by rubbing a mixture of MoS_2 and syrup into intimate contact with the clean steel at elevated temperatures) proved most effectiveness. Observations indicated that the effectiveness of any fretting-corrosion inhibitor is dependent on its ability to prevent metallic adhesion.

"Fretting-corrosion, defined as surface failure that may occur when closely fitting metal surfaces experience slight relative motion, damages many machine parts subject to vibration."

A review of the many applications of molybdenum sulfide showed that it is commonly used in dry form by dusting or rubbing on parts. It is also used mixed with numerous kinds of oils and greases. MoS_2 has also been mixed with various types of volatile carriers as a means of applying it; some of these mixtures may contain a small amount of resin or other type of bonding agent which aids the development of a dry-bonded film having low friction properties. It has also been mixed with plastics, metal powders, rubber, and similar materials to reduce friction and prevent galling.

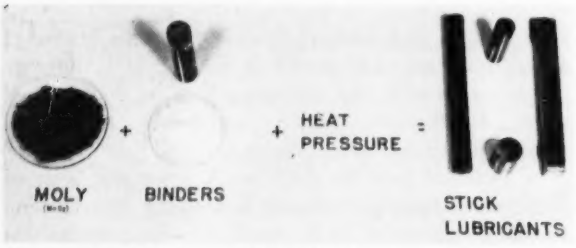


Photo courtesy Baltimore and Ohio Railroad

Illustrated above is the formula used to convert MoS_2 into stick lubricant for use on B & O equipment. Although still in the experimental stage, MoS_2 shows promise in railroad lubrication.

Typical Dry Use Applications

A major use of MoS_2 has been for lubrication of machines and machining processes. Typical of the former is its use in the assembly of new machine tools where it prevents galling during the press-fitting of parts. In the press-fitting of dowel pins, for example, scoring is eliminated and less pressing force is required. Application on new machine tool ways makes the sliding of heads and carriages easy. On grinding machines exposed to abrasive dust, the MoS_2, rubbed on to the surfaces to be lubricated, will keep down friction while permitting the dust to be blown off while the solid film lubrication remains.

Typical of its process application is its use in quenching dies. Previous to its use, steel strip that is hardened by passing through cold dies suffered surface damage. The dies were injured too. Treating die faces with molybdenum disulfide has overcome the trouble. Stability under high temperatures is a decided asset.

Treatment of bolt threads exposed to elevated temperatures by MoS_2, either dry or mixed with oil, reduces danger of thread-tearing on tight fits and facilitates removal at a later date. Typical applications specific to diesel engines would be in cylinder head and exhaust manifold bolts or studs. An extension of this type of application might include such uses of the material as for coating valve seat inserts; precombustion chambers, energy cells, etc., and fuel injectors.

Typical Mixture Applications

The variety of carriers suitable for use with MoS_2 greatly widens its application. Its use in machine and cutting oils has benefited metal-cutting processes. In conjunction with machine oil, it has been successful in broaching low alloy steels with the result that broach life was increased. Mixed with cutting oil it has produced increased tool life as well as better finishes in such operations as straight lathe cutting and thread cutting. In one operation tool life and lathe production were increased by 25 per cent.

In suitable carriers, MoS_2 has been beneficial in hot-working operations such as hot-heading, hot press forging, die forming, and drawing, etc. It has the general affect of preventing sticking and prolonging die life materially.

Gear assemblies appear to be a good field of application for MoS_2. It has been reported that in different assemblies, some heavy duty, there was less starting friction and less wear than had been experienced with the previous type of lubrication.

An interesting example of its use is for the facings of clutch discs and metal brake linings. One per cent by weight is mixed with bronze or iron powder (depending on application), and sintered onto a steel backing. MoS_2 controls the frictional properties of the sintered part and minimizes changes of friction with temperature and moisture content.

When mixtures are used in an application requiring filtration, particle size of the MoS_2 is a consideration. The purpose of the material would be defeated if the filter took out micronic particles of sizes smaller than those of the molybdenum disulfide. Particle size then can be an important consideration. One company markets a product, *Micro-Moly*, with the specification that 95 per cent of the particles are one micron in size, and the remaining percentage of less than three microns. Obviously, filter removal of particles should not be a problem in this case.

Listed above are only a few of the possible applications for this versatile lubricating material. They are given as a basis for stimulating thinking about how it can be used beneficially in the diesel field. Now for some specific applications.

Examples of Railroad Uses

Some idea of the numerous places where molybdenum disulfide may be used in railroad operation and maintenance were given recently in the B & O Magazine, published by the Baltimore and Ohio Railroad. Most of the following is derived from this source as are all the illustrations.

Through its Test and Mechanical Departments, this railroad intends to pioneer the use of MoS_2 for extended railway application. They feel that for certain applications

it is better than any other lubricant. It can be used to lubricate difficult areas where design of the parts or the operating temperatures prevent the use of liquid lubricants. It has shown exceptional load-carrying ability with very low friction.

They point out that a very desirable feature of the material is its capability of being applied to surfaces in a variety of ways. It can be applied dry by either dusting or rubbing into the parts. In various carriers it can be brushed on, and if desired, cured by baking to form a solid bonding film. This latter method has been successful in bonding it to steel, aluminum, brass, stainless steel, and even glass.

It is emphasized however that this material cannot be used as an all-purpose lubricant. There are many applications where well-refined oils and greases will do a better job. For example, an engine crankcase requires a relatively thick film of oil between its moving parts, whereas MoS_2 does its best either where pressures are so high or clearances so slight that only very thin films of lubricant can do the job.

There are however, certain applications within the engine where MoS_2 can be used to advantage as the B&O sees it. Its ability to prevent metal-to-metal contact helps to delay, or prevent altogether, fretting corrosion such as occurs on the backs of engine bearings and pilot bore fits of cylinder liners in the engine frame.

Molybdenum disulfide can help in maintaining the speed and comfort provided by the modern diesel locomotive by eliminating rough spots caused by faulty lubrition in such areas as truck center plates, diaphragms, ball and socket joints of couplers, pedestal liner, and wheel flanges to prevent wear on curved track.

B&O laboratories are now making solid lubricating sticks, from MoS_2 and a suitable binding agent, that are hard enough to withstand continued rubbing contact with a spinning locomotive wheel flange. The idea is that enough MoS_2 will rub off the stick onto the flange to prevent wear and yet not wear the stick away too fast. It is estimated that one of these sticks will wear six weeks in normal operation, cost of materials being less than 30 cents. The chemist, Mr. R. N. Fracalossi, who developed the stick also has done considerable work on compounding the various other lubricant mixtures now under service tests.

A device attached to the trucks of diesels for holding the lubricating stick in place against flange, was invented by Mr. E. A. Compney, supervisor of lubrication of the Mechanical Department. Road tests of this device over a period of 10 months on a number of diesel units have proven its merits. Its use is being extended to road and switching units on all territories of the railroad. They are also experimenting to find ways of applying MoS_2 to the rails to stop excessive wear, encountered on curved track, to both rails and the wheels of all equipment.

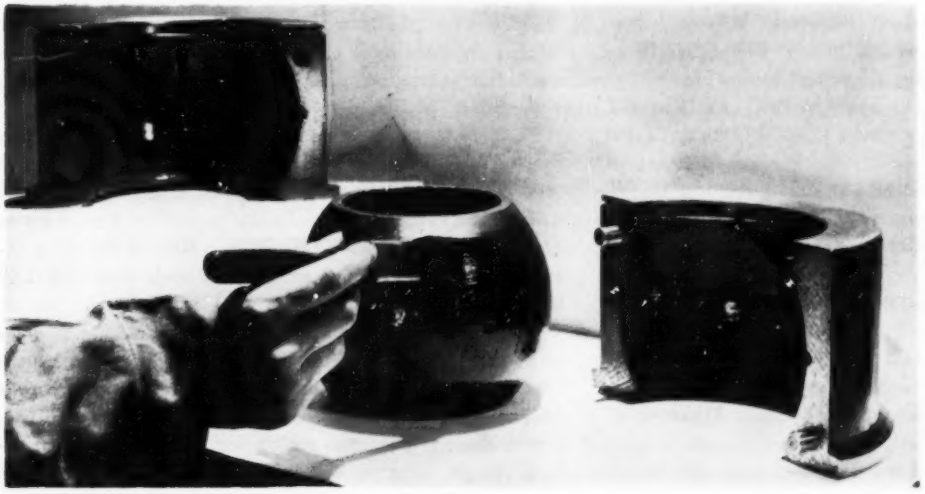
Trucks, not only under diesel locomotives but under cars (all kinds), are subject to wear due to many forces that cause relative and vibrant motion of their parts. Some of the parts suitable for this type of lubrication are: load-carrying pins; roll-stabilizer pins; brake-rigging pins; brake-lever guides; and, truck side frame wear plates to take wear of bolster guides.

In Summary

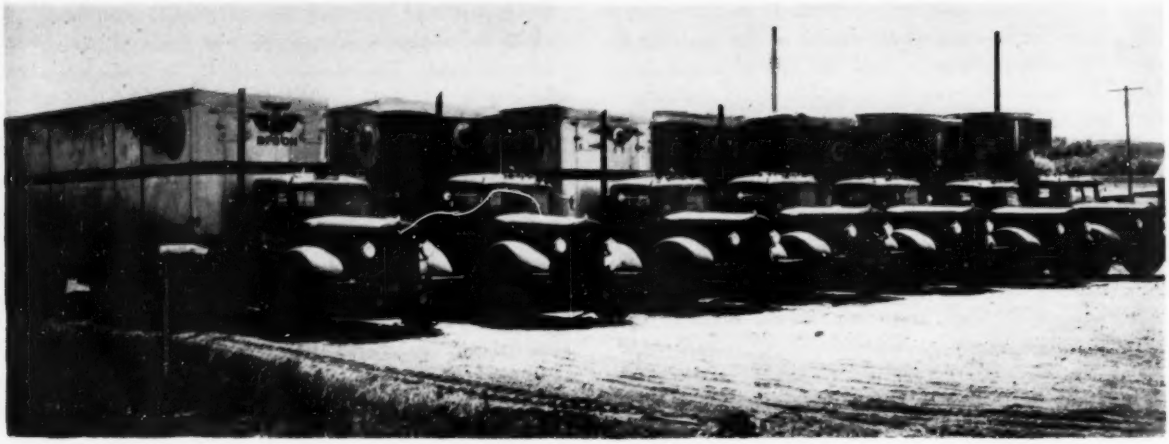
Without a doubt the unique and important properties of molybdenum disulfide, and the numerous methods by which it may be applied, make it suitable for adoption as one of the approved standard lubricants for a great many applications. To lubrication engineers who are constantly in search of better methods and materials that will contribute to better results, this material offers many potentialities. It is not a panacea; each new application must be carefully considered and tested.

Research and experimentation has produced a commercial product of high purity with known properties. It is now a challenge to industry in find out where and how to realize its unique advantages.

Photo courtesy Baltimore and Ohio Railroad



An example of one railroad use, is the application of molybdenum disulfide to a locomotive ball joint.



Seven of the ten Autocar tractors in Bison's fleet. Repowering their fleet of ten tractors with diesels has saved the Bison Line $22,900 in one year.

Bison Freight Line Repowers

Repowering their fleet of 10 Autocar tractors, has proved profitable for Bison. In one year, the change-over from gasoline to diesel power has saved this outfit $22,900.89.

Today, the Bison Freight line operates over a 550-mi route between St. Paul, Minnesota and Dickinson, North Dakota, However, back in 1934, Pete Peterson and his sons, Earl and Clarence started out with one truck hauling livestock from Millerton, North Dakota to St. Paul, Minnesota. Now, their fleet consists of 17 tandem-axle trailers and 10 diesel-powered tractors of the 3-axle class. During the period from October 1950 through September 1951, these rigs hauled nearly 48 million lb of freight between the company's five terminals.

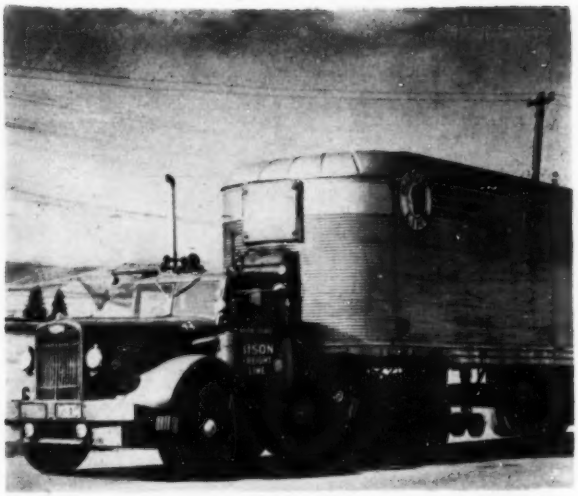
Bison's first diesel was purchased in 1946 in a DC-100-T Autocar. This engine was a model HB-600 Cummins rated at 150 hp. Later the engine was changed to a model HRB-600 and was still in service in 1951. Autocar C-70-T tractors have now been standardized on, with model NHB-600 Cummins engines rated at 200 hp as the source of power.

Running Time Cut—Since repowering took place, two hours have been sliced off running time of overnight freight between St. Paul and Bismark. This has been accomplished without increasing maximum speed of the rigs over the 450-mi haul. Clarence Peterson, Manager of Bison's St. Paul terminal, attributes this reduction in running time to the ability of the diesels to maintain higher average road speeds than were possible with 165-hp gasoline engines.

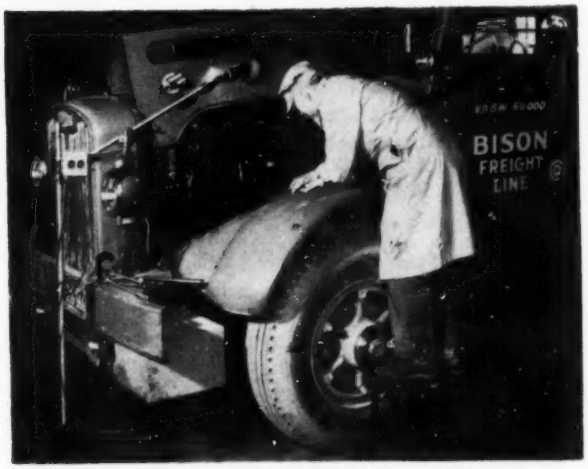
Heavier Payloads Hauled—Maximum payloads of 16 ton became possible in 1951 with the addition of tandem rear axles to the tractors. Theoretically the same load could have been hauled with the tractors having only a single rear axle. However, trailer axle loading limits could not be held to within legal limits had trailers been loaded to maximum capacity. Formerly, 14 to 15 ton were the maximum payloads possible with single rear axles.

Fuel Savings have been 2.61¢ per mile with tractors averaging 5.51 mpg for 709,606 mi at an average cost per mile of 3¢ during the 12-mo period from October 1950 through September 1951. In the preceding year, 10 gasoline engines averaged 4.09 mpg for 346,555 mi at an average cost of 5.62¢ per mi. The diesels averaged 1.42 more mpg and saved 2.61¢ per mile in fuel costs.

Maintenance Costs Cut—Average maintenance costs for the 10 diesel-powered tractors were 6/10¢ per mile lower than for the gasoline-powered rigs. Cost records indicate that $12,105.40 was spent in the 709,606 mi operated during the same period for labor, parts, lubrication, outside repairs, and miscellaneous expenses on the



Illustrated above is one of Bison's C-70-T Autocar tractors powered by a model NHB-600 Cummins diesel. Bison has standardized on this model rig and engine.



To extend equipment life, Bison's mechanics follow a well planned preventive maintenance program. Since repowering, tractor and engine maintenance costs have been reduced to 6/10¢ per mile.

diesel-powered tractors. This averages out to 1.72¢ per mile for diesel operation. During 1950, maintenance expenses for the gasoline-powered units was $8074.51 in 346,555 mi of operation, an average cost per mile of 2.33c.

Like all truckers, the Petersons are extremely cost conscious. The advantages of repowering this fleet are clearly shown in the operating cost comparison between gasoline and diesel power. Diesels have enabled the Bison line to cut operating and maintenance costs as well as running time.

Fleet Operating Cost Comparison

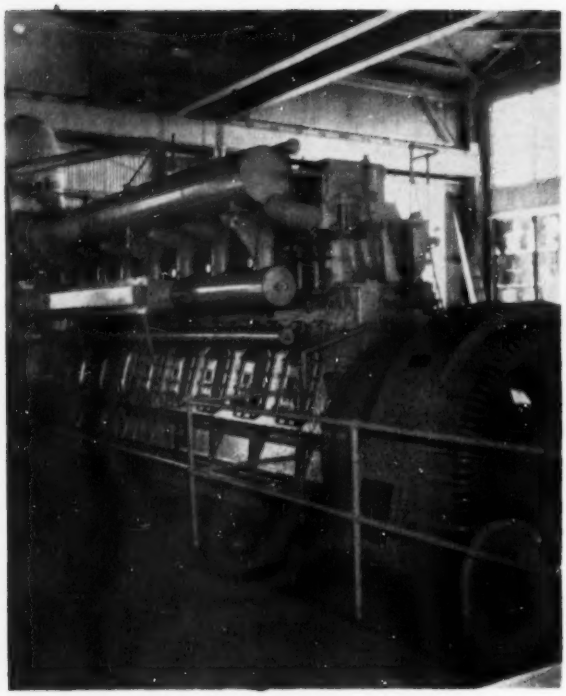
Cummins Diesel and Gasoline Operation

Engine	Cummins Diesel	Gasoline
Operating Period	October 1950 through Sept. 1951	January 1950 through Dec. 1950
Total Miles Operated	709,606	346,555.
Total Tractor Operating Cost	$33,454.78	$27,533.21
Total Cost per Mile	$ .0472	$ .0795
Fuel Used—Gallons	128,766	84,995
Miles per Gallon	5.51	4.09
Total Fuel Cost	$21,349.88	$19,458.96
Fuel Cost per Mile	$ .0300	$ .0562
Tractor Maintenance—Labor	$ 5,561 60	$ 3,297 06
Tractor Maintenance—Parts	$ 3,831 03	$ 3,223 76
Tractor Maintenance—Lubricating Oil	$ 1,541 22	$ 837 81
Tractor Maintenance—Outside Repairs	$ 870 08	$ 418.09
Tractor Maintenance—Miscellaneous	$ 301 37	$ 297 79
Tractor Maintenance—Total	$12,105 40	$ 8,074.51
Tractor Maintenance—Per Mile	$ .0172	$ .0233

Bison Freight Line—Cummins Diesel Powered Tractors

Operating Summary from October 1950 through September 1951

Tractor No.	Tractor Model	Horse-power	Model	Date Installed	Miles Operated	Fuel Used MPG	Total Cost Per Mile	Fuel Cost Per Mile	Maintenance Cost Per Mile
41	C-70-TS	150	HB-600	July 1948	51,000+	5.12	$.0632	$.0330	$.0302
44	C-70-T	200	NHB-600	Sept. 1950	78,416	5.27	.0433	.0308	.0125
45	C-70-T	200	NHB-600	Mar. 1951	36,270	5.79	.0501	.0283	.0218
46	DC-100-T	165	HRB-600	July 1946	60,805	5.28	.0493	.0331	.0162
52	C-70-T	200	NHB-600	Sept. 1950	100,960	5.83	.0385	.0284	.0101
54	C-70-TS	200	NHB-600	April 1951	50,830	5.50	.0458	.0287	.0171
65	C-70-TS	200	NHB-600	May 1950	67,225	5.82	.0477	.0290	.0187
89	C-70-T	200	NHB-600	July 1950	98,415	5.63	.0456	.0295	0161
90	C-70-T	200	NHB-600	Dec. 1950	62,055	5.12	.0521	.0319	.0202
91	C-70-T	200	NHB-600	June 1950	103,030	5.54	0473	.0297	.0177
			Fleet Average		70,900	5.51	$.0472	$.0300	$.0172



Arrangement of the aftercooler on the manifold side of the engine can be seen above.

Controlling Combustion in Dual-Fuel Engines

By W. M. Kauffmann
Chief Engineer—Engine Division
Worthington Corporation

Operation of engines on two fuels presents problems characteristic of each type that must be solved. Here are Worthington's approach and solution to some of these problems.

Combustion control in dual-fuel engines is intimately related to the design and application of engine components as well as the processes involved in the efficient utilization of both the liquid and gaseous fuels. Some of the more important of these will be discussed.

Perhaps the major consideration with respect to liquid fuels concerns the fuel injection system and provisions for governor control. Gaseous fuel is somewhat more of a problem, involving method of admission and metering to achieve balance among cylinders; control of air/fuel ratio for better part-load efficiency; control of detonation; and once again, over-all governor control.

Fuel Injection Equipment

The first requirement for correct combustion in dual-fuel operation is consistent, regular pilot injection for every power stroke, free of any cycling or missing. Unless this is obtained every other effort will be of no consequence. After research with various systems, both in the field and in the laboratory, we undertook the development of our "dual-plunger" pump.

After many months of effort, the pumps were tested on oil-diesel operation to check their performance. Results were most gratifying. Combustion pressures were found to be lower due to a slight pilot injection advance inherent in the design.

These pumps were then installed on oil-diesel engines for the Trans-Arabian Pipe Line that burned a light crude oil having such a large percentage of wax that the fuel was heated to prevent congealing in the injection system. Later, installation was made at City of Tarboro, N. C., where 350 SSU at 100°F heavy fuel when heated to 185°F was injected, with very favorable results.

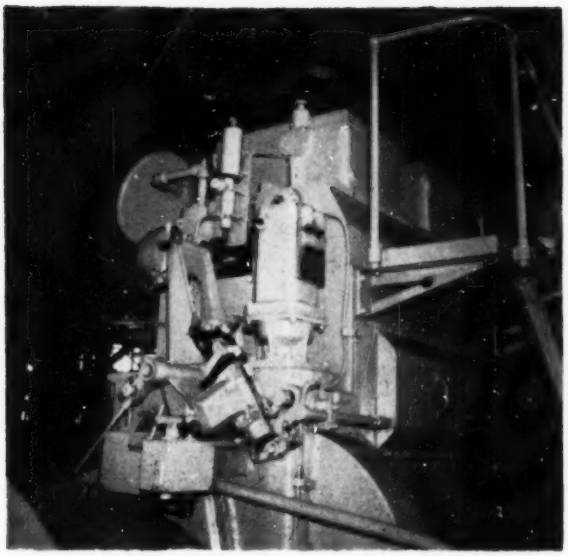
Experimental pumps of as low as 3 per cent pilot oil quantity were then installed in selected dual-fuel installations. In every case, operators and our field service reported complete confidence in the equipment. With this background, decision was made to introduce the "dual-plunger" pump for all Worthington dual-fuel engines.

Pumps are made in two sizes, "C" and "D". In engineering the fuel system, the main plunger is tested to suit oil-diesel operation. The correct nozzle is then checked stroboscopically with racks at "zero" to insure proper pilot injection. To complete the system tuning, correct fuel line size is also established.

When correct, the pilot injection spray pattern exhibits a good degree of penetration with no evidence of heavy secondaries. The fuel cams are identical to those of the standard oil-diesel injection pumps. Nozzles are of the Bosch AKK type in which the nozzle spring seats directly on the top of the needle valve, thus obtaining a minimum of inertia effect and therefore assisting in proper atomization of the small quantity of pilot fuel. Cooling of the nozzles has not been found necessary.

Governing

Improved regulation has been made possible by utilizing the full governor stroke for both oil-diesel and dual-fuel operation. In order to maintain an automatic change-over feature for gas failure emergency, a simple control



Illustrated here, are automatic changeover device for full governor travel and operating cylinder (in back of governor).

is incorporated in the governor linkage that rapidly makes the change from full governor travel on gas control to full governor travel on oil-diesel operation.

In this manner, the inherent regulation characteristics of the standard oil-diesel engine is retained regardless of the fuel being used. This is an important factor, in conjunction with other features to be discussed, in overcoming "meter swing" tendencies on gas operation.

It may be added that larger WR_2 flywheel and closed damper windings in the generator improve electrical characteristics of the dual-fuel engine.

Admitting and Metering Gas

The importance of balancing exhaust temperatures and combustion pressures on gas operation independent of the oil-diesel balance, cannot be overemphasized. This is particularly urgent in generator power plants where kilowatt meter swing cannot be tolerated.

A good many dual-fuel installations have accepted with some reluctance the fact that meter swing is present to varying degrees, whereas none is experienced with oil-diesel operation on the same engine. This is explained by the fact that governor response to gas/air ratios is delayed by the increment of time essential for the engine to adjust itself to the altered condition of mixure in the cylinder. In oil-diesel operation, the response to fuel cutoff is almost instantaneous since the fuel to be burned is very rapidly regulated by the injection system. Effect of inherent ignition lag or delay in the dual-fuel engine has been reduced by improving air/fuel mixture.

To achieve this, as well as balance among cylinders, gas fuel must be accurately metered and timed for each cylinder with an absolute minimum of leakage past the metering valve. Also the fuel gas and air must be thoroughly mixed before entering the combustion chamber.

Our research has shown that a balanced type metering valve having a parabolic area/lift function obtains the proper gas metering over the engine load range. This valve has been described in various engine magazines in recent months. It consists essentially of three flats, accurately milled on a cylindrical surface. By adjusting the lift of these valves for individual cylinders, it is possible to attain a combustion balance on all cylinders that does not exceed 20°F between elbow exhaust temperatures.

We have also determined that a separate gas injection valve, timed for its own cam, permits the optimum mixture condition. A diffuser for directing the gas, as a jet, into the air stream was found to result in substantial improvement in fuel economy. Field tests have consistently been checked at 6250 Btu/bhp/hr for full load, equaling a thermal efficiency of approximately 41 per cent.

Controlling Excess Air

Shortly after the introduction of the supercharged dual-fuel engine, it was found that partial-load economy was not good. Tests in our research department showed that considerable reduction in fuel consumption could be obtained by throttling the air discharge from the turbocharger. It was recognized that with best over-all economy, exhaust stack temperatures remained fairly constant with throttling.

It was apparent that a controlling method which could maintain a constant exhaust temperature would be suitable and would also provide for any change in ambient temperature. Thus, where temperatures would vary from 100°F in summer to zero in winter, nc loss of fuel economy would be experienced as the throttle could be partially closed even at full load.

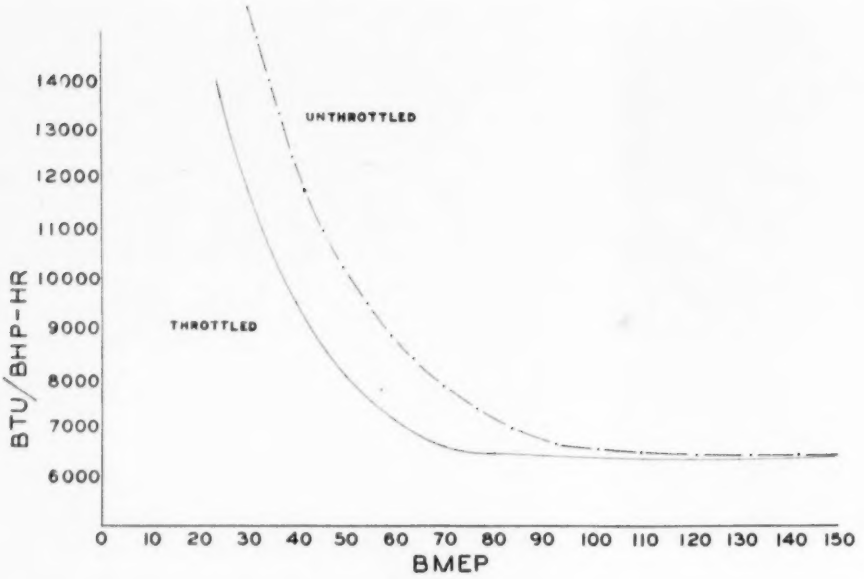
The "Thermal Control System" developed has also been much described of late. This unit consists essentially of a temperature-sensitive element, placed in the exhaust stack, which heats and expands a column of inert gas in a small flexible tube. This operates an air pressure controller which, in turn, causes a positioner to move a diaphragm valve. Sufficient energy is provided to move the butterfly throttling valve placed in the turbocharger air discharge pipe.

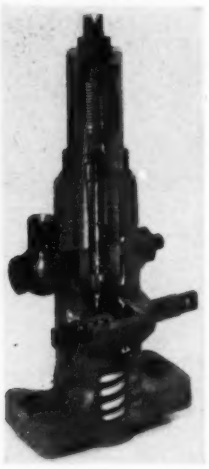
Once properly set, operation of the control is automatic. Orsat analysis taken during shop tests showed an almost constant air/fuel ratio from quarter to full load with the control in action. Combustion was definitely improved. There was a noticeable smoothing out of operation after transition from running at light load without throttling, to the automatic throttling control.

Controlling Detonation

The problem of combustion control of dual-fuel engines would not be complete without discussing detonation. This has been experienced to a varying degree in power plants, particularly in the hot, dry climate of the Southwest.

This brings to light the fact that in some respects the dual-fuel diesel engine acts like a true gas engine. It has been theorized that, due to the high mixture temperature associated with diesel compression, methane, ethane, and





Above is a cutaway view of the Worthington dual-plunger pump. Curves at left show dual-fuel engine effect of air throttling.

other constituents of the gas break down into forms of peroxides and aldehydes which have pro-knock characteristics.

Under certain conditions, mixture at the periphery of the combustion chamber will ignite ahead of the flame front of the fuel jets, giving off sharp raps. We have called the load at which this occurs the "knock limit" for the particular engine being tested.

It has also been observed that as bmep rating is increased, the manifold air temperature must be reduced to raise the knock limit. This has given the dual-fuel engine two new accessories—the precooler and the aftercooler. We have used successfully the evaporative type precooler, ahead of the turbocharger, in conjunction with an aftercooler in an Arizona installation. At a 115°F ambient temperature with 5 per cent humidity, the precooler reduced the air temperature to 76°F. It was then heated by compression in the turbocharger (with 10 per cent overload on the engine) to 146°F and cooled by an aftercooler to 90°F, using a limited supply of 75°F well water. With 90°F manifold air temperature, it was possible to operate at 10 per cent overload without knock; whereas tests without air cooling would not permit more than 90 per cent load at this ambient temperature.

Degree of cooling required will depend on the engine bore. Smaller bore engines are less sensitive to the effect of knock, probably due to the greater cylinder wall cooling area for the given displacement. We have, however, recently established a practice of supplying aftercoolers with all increased-rating supercharged dual-fuel engines. Where water conditions prevail with temperatures of 80°F, 95°F manifold air temperature may be obtained with proper aftercooler design.

Increasing of ratings to 135 bmep and over will require careful analysis of the aftercooling problem to obtain knock-free performance and thereby correct combustion control. Where temperatures of the water supply for aftercooling exceeds 80°F, it may be necessary to resort to refrigeration of the coolant circulated through aftercooler heat exchanger.

At present, we are operating such an absorption refrigeration system activated by steam. This may be obtained from exhaust or the Vapor Phase cooling system of the engine. By this method, aftercooler water temperature may be reduced to 45°F. Manifold air temperature of 60°F has been obtained, thus permitting knock limit to be increased in excess of 160 bmep.

Closely associated with combustion is the analysis and condition of the gas. The presence of free hydrogen will reduce the knock limit. Entrained lubricating oil, or liquid ends in the gas system, adversely affects operation. The use of corrosive fuel gas will result also in high maintenance unless a scrubber of some sort is placed in the gas line ahead of the pressure regulators.

Aftercooling is likewise beneficial to oil-diesel operation, resulting in reduced heat rejection to the cylinder jacket cooling; thereby obtaining a definite improvement in thermal efficiency. The direct result is a noticeable reduction in fuel consumption on oil.

Summing Up

With the ever increasing availability of gas fuels, it appears that the gas-burning engine will continue to fill a definite and increasing field in the power plant field. Also, we have recently noted a renewed interest in spark-ignition gas engines and have already placed in operation several supercharged units of this type.

In either the higher compression spark-ignition engines or dual-fuel engines, the problems in burning gas is essentially similar. Close attention must be paid to the system of ignition—pilot oil or electrical spark—for good combustion. Problems of control, admission and metering of the fuel, balance among cylinders, maintenance of optimum air/fuel ratios, and control of detonation are essential if good combustion control is to be achieved.

This close-up shows the frequency meter mounted on the unit. The three capacitors shown have been cut out of the circuit.

At the site of New York City's new South Shore Destructor Plant, the diesel-electric set is shown powering the six welding machines required for construction.

A Field Problem In Instrumentation

Isolating vibration from frequency meter permits accurate setting of controls for proper generator output characteristics.

Equipment operation presents many problems. A while back, the Lehigh Construction Company, steel erection subsidiary of Lehigh Structural Steel Company, Allentown, Pa., experienced some trouble with the application of a portable engine-generator set as a power source for electric welders. Lehigh, which has done much in pioneering welded steel buildings, uses this unit to supply power for welding machines at the job site.

However, before we go into the problems and their remedies, let's take a look at the equipment. The engine is a model 21, 6-cyl, 5¾-in by 6½-in Murphy diesel direct connected to a 100 kw Electric Machinery generator. Rating for the engine is 150 hp at 1200 rpm. Welding machines powered by this unit are of the dry-plate selenium rectifier type.

Previously, welding machines of the rotary motor-generator type were used. To correct the power factor of these rotary units, three capacitors of the chlorinated diphenyl type were installed on the generating set. When the change was made from the rotary to the dry-plate type machine, a leading current was encountered. This condition caused damage to several of the new welding machines. Here, two things were necessary to eliminate further damage.

First, the three capacitors were cut out of the circuit as they were no longer needed. This eliminated the leading current condition. Next, a frequency meter was installed to afford the operator with some means of controlling generator output at 60 cycles, desirable for operation of the new machines. This was not the end however, as the problem of dampening vibration between the frequency meter and the prime mover was encountered.

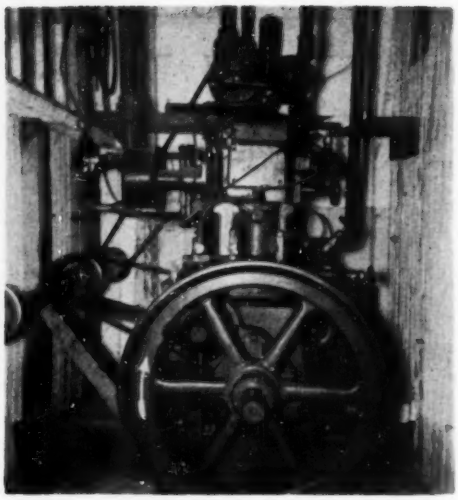
Although the frequency meter was equipped with rubber vibration isolators, the normal vibration impulses of the skid-mounted power source were transmitted to it. In other words, frequency indicated on the meter was not necessarily the electrical frequency of the generator output, but was a combination of that and the superimposed engine vibration. Several tries were made to isolate the frequency meter from the prime mover.

When it was found that vibration could not be controlled by using dampers on the frequency meter alone, a sponge rubber pad was placed between the rheostat box and mounting bracket for the frequency meter. Along with this, large rubber washers were placed on the mounting bolts. Again, vibration transmitted to the frequency meter proved too great.

Finally, a satisfactory system was developed by using a non-rigid mounting. This was accomplished by placing a nut and jam nut on the frequency meter mounting studs and passing the extending portion of the stud through oversized holes in the mounting bracket. A second nut and jam nut were then placed on the studs, with care taken to allow clearance between the nuts and the bracket. With this arrangement, when the unit is in operation, the frequency meter is not solidly connected to the mounting bracket.

This system has been successfully used in the field for over a year. It has been possible to set and maintain proper generator output characteristics. Prior to the development of this arrangement that was worked out by Albert Felsher, field mechanic for Lehigh, it was hard to tell exactly what the output characteristics were. A welder might set his machine, climb up on the steel structure, and then have to come down and reset his machine after striking a poor arc.

This caused a loss of time to the company and a loss of footage to the welder. Multiply the time lost by 10, which is the number of welding machiines that can be powered, and lost time rapidly mounts. This is not necessarily the answer to all such problems as various other engineering principles could apply. However, it is indicative of the ingenuity that can be used for eliminating troublesome problems in the field.



Shown above is one of the small engines sold, installed and serviced by Mr. Stoltzfus, powering a milking machine, milk cooler, and line shaft.

Illustrated at the left are exterior and interior views of Mr. Stoltzfus' shop at Gap, Pa. The interior view shows only a part of the well-equipped shop.

Where Are Small Engines Going?

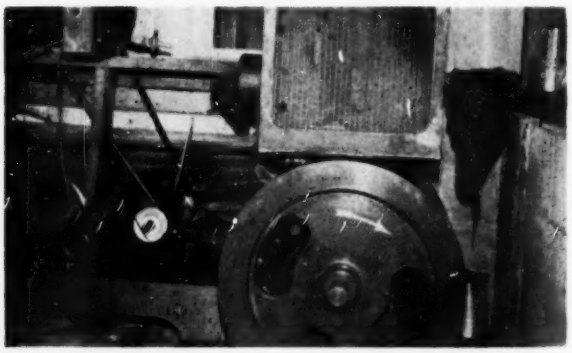
Small engines are being sold. However, if you were asked to put your finger on just where they are being installed, categorically, you would be hard put to do it. Probably the main reason for this is their end use is not always known, since in most cases they are sold as packaged units across the counter. Although the small diesel has certain definite applications, there are many uses which will be dictated by a combination of circumstances that create a need for a cheap, reliable source of power.

In outlying areas where power is not available from a local source where it would be necessary to string long power lines to supply only a small amount of power, the small diesel may be found in fairly large numbers. There are, of course, exceptions to this as small engines are also fund in areas where local power is available. Such is the case at the end of long-reaching power lines where power failures frequently occur due to storms or other conditions. Here, diesels are often used for stand-by service to protect against power failures.

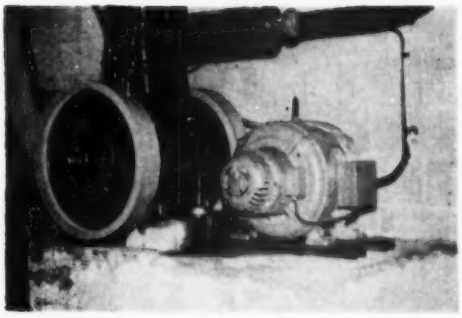
For an example of small engines being used in conjunction with local power, let's take a look at an average-size farm where a source of power is needed in the field for water pumping. The water might be used for either irrigation or livestock watering. In any case, it would be costly to erect and maintain power lines across the fields of this farm. However, water pumping is not the only use for the small engine.

Small portable engines can also be moved from one place to another to power other farm equipment. In some cases, engine-generator sets furnish all the power for a farm or house in an outlying area where outside power is available. This situation may be found in many places where the diesel's inherent economy and dependability betters that of purchased power.

To illustrate what is actually being done with small diesel engines in one area, let's take a look at the country



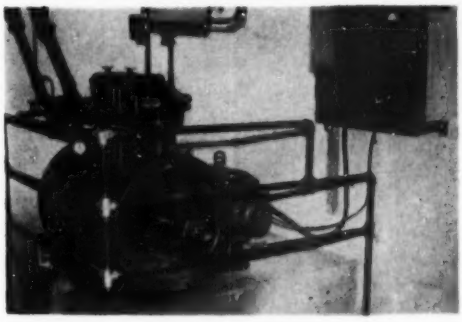
Another farm installation shows a small diesel driving a milk cooler and an automotive-type generator for charging batteries.



A Bamford model Z3 (above) driving a 5 kw generator, supplies power for the poultry house at left. Power requirements include, lighting, water pumping, a circulator in the heating system, and ventilating motors.

surrounding Gap, Pennsylvania. This town is located in the agricultural portion of Lancaster County. If you were to take a map of Lancaster County and, starting with Gap, put in a pin for every small diesel installation, you would be over the 200 mark before getting very far away.

Most of the small engines in this area, Listers and Bamford (a British engine) have been sold and installed by Mr. M. S. Stoltzfus, an engine dealer located in Gap. Since June of 1950 Mr. Stoltzfus has sold over 200 engines, the majority of which are used on surrounding



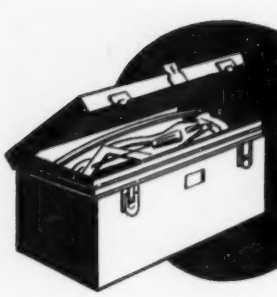
Although power is available from an outside source, a local machine shop prefers the dependability and economy of this 12 hp diesel driving an 8 kw generator.

Hay drying is another application for the small diesel. The fan at left is belted to the 1-cyl Lister engine shown below. This installation is also used for drying grain and powering a milk cooler. Here, dependable power is a must once wet hay is put in the barn.

farms. In addition to selling engines, Mr. Stoltzfus maintains a well equipped shop for installation and servicing.

Applications for these engines vary. They can be found supplying power for all or part of a farm. In many cases these units are preferred over local power. Some units supply power for local carriage and machine shops, whil others operate hay-drying fans, milk coolers, or genera tors. Drives also vary with the use. In many installations, additional equipment has been added, especially on farms where the favorite seems to be a small automotive-type generator for charging batteries.

In summary, it might be well to point out that this is only one area and cannot be classed as typical, since in another area the dictating factors will probably differ greatly. However, this will serve to show what a local dealer can do when potential market is seen in an area.



Straight from the Tool Box

This is YOUR Department. Pass along your ideas to the other fellow. Send items to the Editor, preferably with a picture or sketch. Contributors will receive $10.00 for each item upon publication.

Avoid Prestressing Pilot Bearings

JACK SAWYER, SAN DIEGO, CALIFORNIA—I don't know how many of the old war-surplus Gray Marines with the Twin Disc reverse gears are still kicking around, but I learned something about installing the pilot ball bearings in them that applies in a lot of places. I thought that I would pass the idea along.

Some time back, we had a job overhauling a lot of these engines. They worked fine until a lot of them started coming back with burned-out reverse shaft pilot bearings. At first we thought that they were not being greased, but after taking off the grease fitting at the end of the shaft and probing the bore with a stiff wire, we found that they were full of soft grease. In fact, characteristic spider patterns on the back plate and grease on the clutch plate showed that some had been overgreased.

After a lot of head-scratching, I had a brainstorm. The reverse pilot bearing was being forced into the recess in the back plate and when the reverse gear housing was boltd to the bell housing and the clutch assembly bolted to the flywheel, the pilot bearing extension on the reverse shaft was being forced into the bore of the bearing's inner race. I figured that perhaps the shaft wasn't seating properly and by keeping pressure on the inner race, was keeping the balls under a load.

The same sort of trouble was common in throwout bearings when the yoke was not properly adjusted for the neutral position, and you can get the same trouble by "riding" the clutch on a car. Now the question was how to lick the trouble.

Fortunately in this case, the reverse shaft extends right through the unit. I machined up a piece of bronze propeller shaft so that the OD was the same as that of the reverse shaft and bored out the center to clear the grease fitting. After the reverse gear was bolted into place and the clutch made up to the flywheel, I put the bronze drift against the shaft and gave it a few healthy belts with a 3-lb hammer. There was enough end-play in the other bearings to give a little movement and this seated the shaft in the pilot bearing.

The little end-play obtained was enough to overcome any prestressing of the pilot bearing and our troubles from this source disappeared. This is a good stunt to remember in all shafting mounted in ball bearings. They should have a little room to breathe.

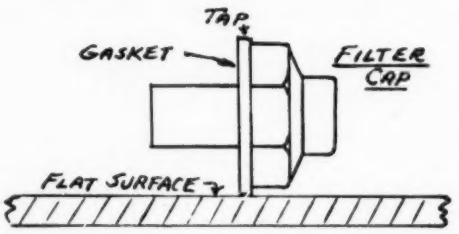
Shades of New Guinea! It is a coincidence that we had the same trouble during the war, both with the pilot bearings and the throwout bearing. We licked the first trouble the same way and the second by better adjustment of the control linkage in the LCM's. Avoidance of prestressing anti-friction bearings is a good point to keep in mind as it has wide application. —EDITOR

Tip on Filter Cap Gaskets

JOHN J. HENDERSON, ASHVILLE, NORTH CAROLINA—I would like to pass on a tip that I have found to be helpful in removing GM filter cap gaskets. Sometimes the gasket is compressed tightly around the shoulder of the cap and removal is very difficult.

My solution is to lay the cap on a flat surface (brass or iron), and then tap the edge of the gasket lightly with a small hammer. I then give the cap a quarter turn and tap lightly again. This procedure stretches the gasket enough so that it may be removed from the shoulder of the cap with little effort. The gasket can be used again providing it is not hit hard enough to seriously damage it.

I have noticed some men trying to remove the gasket with a screwdriver, knife or pliers. They found my



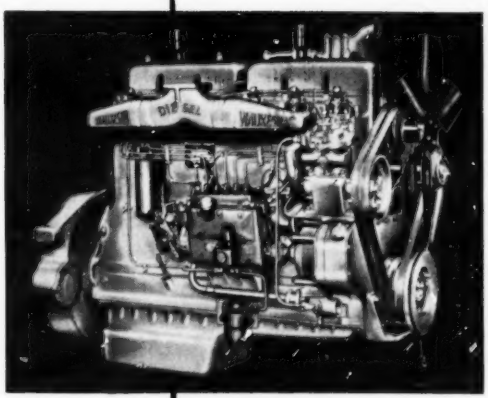
suggestion very helpful; maybe someone else can benefit from it, too.

This seems to be our month for GM ideas, but as before —the idea also has wider application—Editor

Loading logs at Trinidad, near Eureka, California.

WAUKESHA

148 Diesel



219

148-DKB High-Duty DIESEL—six cylinders, 5¼-in. bore x 6-in. stroke, 779 cu. in. displacement, 200 maximum hp at 2100 rpm.

It's power-packed for movability—in handling big logs, or ease in maneuvering for fast, economical loading. That's why *Skagit* picked this power plant—the 148-DKB Waukesha Diesel—for their SJ-8 heavy-duty self-propelled Heel Boom Loader and Mobile Yarder. This is *the* combination that's making modern logging records, one after another. And this is the High-Duty Diesel with so many exclusive Diesel-design advantages. Most outstanding is its patented spherical combustion chamber—for clean burning, lively acceleration, smooth shock-free operation, high fuel economy with low maintenance. Send for Bulletins.

WAUKESHA MOTOR COMPANY

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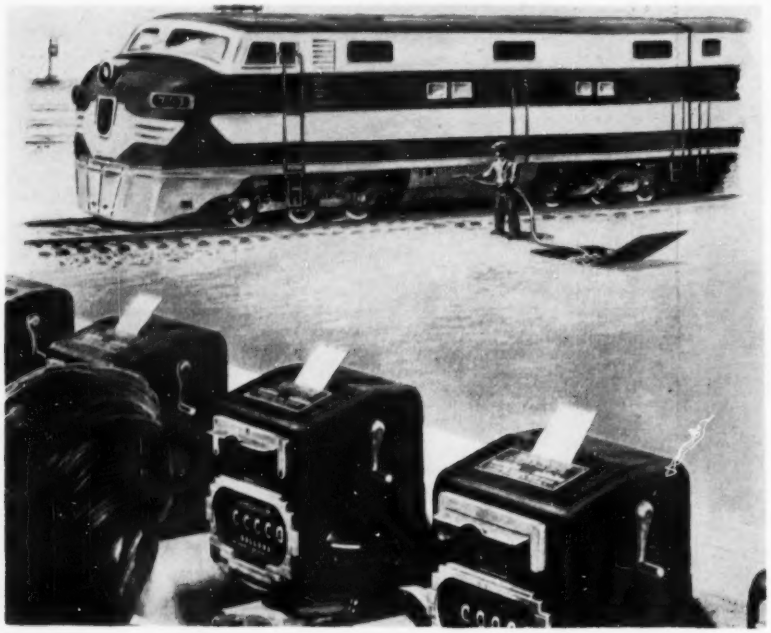
New Products



Remote Registering Fueling System

Development of a system of remote registration for fueling diesel locomotives was recently announced by Rockwell Manufacturing Company. The system evolves around a bank of ticket printing registers installed in a dispatcher's office overlooking the fueling area.

Each of these registers is electrically synchronized to a transmitter on a corresponding meter register outside. As gallonage is dispensed, an exact counterpart of the meter register reading is recorded on the office register. A number of advantages are offered in this system over other methods of metering fueling operations as control over all metered fuel outlets is placed in the hands of one supervisor. No fuel can be drawn until he inserts a ticket in the proper printing register and activates the matching electrical circuit. When delivery is completed, tickets show the exact amount loaded.

In addition to providing positive proof of actual fuel dispensed, carbons of these tickets can be used for inventory control or to verify tax payments.

2-Way Mobile Radio Equipment

New equipment for 2-way mobile radio communications in the UHF band is being produced by the RCA Victor Div., Radio Corporation of America, Camden, N. J. The new equipment, designated RCA type CMU-10A mobile transmitter-receiver will make possible a major extension of radio service in 80 newly assigned FCC channels in the 450-470 megacycle portion of the spectrum.

New Masonry Drill

Dust packing causing stalling is said to be overcome by the design of a new masonry drill introduced by Holub Industries, Inc., Sycamore, Ill. The drill can be used for continuous drilling of concrete, stone, brick, etc., as well as copper, brass and other soft materials.

A combination of oval flutes, narrow lands and fast spiral carries the dust out of the hole as fast as it forms. Less pressure is therefore required and drill can continue to desired depth without stopping to clean the hole. The drill can be used with any tool.

Stabilized No-Swing Crane

A stabilized crane, eliminating usual swinging of a load being hoisted or transported from one area to another, has been developed by the Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, Ohio. Elimination of load swing is of help in speeding tank dipping and various assembly operations, and for supporting x-ray equipment used for making studies of long objects. It also makes possible delivery of hot metal in a foundry direct from cupola to molding area.

The crane has a simple arrangement of hoisting ropes which form a triangular suspension to permit a load to be raised or lowered a considerable distance and still remain rigid.

New Truck Weighing System

Weber Instrument Co., Div. of Link Engineering Co., 13841 Elmira Ave., Detroit 27, Mich., has introduced a system of supporting truck, truck-trailer and bus bodies on air cushions designed as a means of weighing a load and providing a more stable ride. The vehicle is maintained level regardless of unbalanced load, and at constant height loaded or unloaded. Increased air pressure automatically compensates for undue depression of an air cushion, keeping vehicle on an even keel.

A gauge provides accurate weight readings. The driver will know when he has reached his load limit before leaving the dock. He will also know the correct weight of an item as soon as loaded on, for determining shipping charges. Unintentional loading is thus said to be prevented. The system operates off the air brake line and requires only 20- to 50-lb pressure to support as high as 9000-lb weight on one air cushion.

8000°F Arc-Torch Cuts Stone

A new, patented process for cutting and piercing stone, concrete and refractory materials, trade named "Dyn-Arc" has been introduced by Eutectic Welding Alloys Corp., 172 St. and Northern Blvd., Flushing, N. Y.

The DynaTrode arc rod creates its own arc, requiring no ground, and does not have to be struck upon metal. Operator has complete control and he determines where the arc will start. The arc will operate in mid-air and resembles a flame in appearance, with reach of 5- to 8-in.

Technically, the DynaTrode is a self-energizing arc rod. The heavy coating is reduced more slowly than the core. This forms a crucible or tube of coating through which the energy is concentrated to a fine tip and its character changed by the disintegrating coating. Thermal ionization of the coating by the arc stream combined with the concentration produces the conditions necessary to pierce and melt the refractory material.

Wherever a DC welding machine is available of 400 amp or more capacity, the process may be used. Should metal require cutting or piercing, the metal cutting electrode, CutTrode may be exchanged for a DynaTrode and the whole operation carried out with a standard welding machine. It should prove handy around a plant where welder changes, etc., are necessary.

Frequency Correcting Device

A new instrument for detecting and recording frequency errors in the AC output of power plants is being produced by the Industrial Div. of Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa. The device, an electronic time deviation detector-recorder, indicates needed adjustments of frequency output, and thus assures the correct operation of electric clocks and other timing devices on the line.

The unit is designed so that if maintenance is needed on the recorder, the detector continues to operate independently. When the recorder is again attached, it will indicate any error, correct to within 10 sec, which occurred while it was shut down.

Standard Metal Cutting Saw

Peerless Machine Co., 1600 Junction Ave., Racine, Wisc., announces a 10- by 10-in standard model metal cutting saw to replace its 9- by 9-in standard. The saw is an overarm type with an open frame to permit loading from front or side. The frame also has replaceable bearing shoes so that a user can replace the bearings instead of the entire saw frame.

Gauge for Groove Diameters

Rimat Tool Co., 21 W. Dayton St., Pasadena 2, Cal., has introduced a new line of gauges made small enough to enter a .310-in bore and measure groove diam for "O" ring AN6227-6 and snap ring groove NAS-50-31. Measurement of thread reliefs, bypass reliefs in hydraulic mechanisms, and small bores are among various other uses.

PROTECTION
FOR YOUR
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You'll never be faced with engine damage caused by oil pressure failure or overheated cooling water IF you equip *your engines* with PENN Safety Controls.

At the first hint of lube oil pressure failure or overheated cooling water, the PENN Control snaps into action. It will sound an alarm, flash a warning light, or stop engine operation . . . *whichever you choose.* Then, you can investigate and correct the minor trouble before serious damage occurs. Thus costly engine repairs and loss of production time are avoided.

Learn more about this *low-cost* protection for new and old engines. Write **Penn Controls, Inc., Goshen, Indiana.** Export Division: 13 E. 40th Street, New York 16, N. Y., U.S.A. In Canada: Penn Controls Limited, Toronto 13, Ontario.

PENN
AUTOMATIC CONTROLS
FOR HEATING, REFRIGERATION, AIR CONDITIONING, GAS APPLIANCES, PUMPS, AIR COMPRESSORS, ENGINES

PROTECTED BY NUGENT pilot fuel oil filtering, the Fairbanks-Morse 1600 H.P. dual-fuel engine illustrated is establishing a "record" for dependable, economical service at the Wells, Minnesota Power Plant. Formerly a straight diesel, this opposed-piston engine was converted to duel-fuel operation in 1951 and in the next eleven months $19,000 was shaved off the fuel bill. This unit is one of the first Fairbanks-Morse opposed-piston engines ever to be converted to duel fuel operation.

By keeping the vital pilot fuel oil free from dangerous foreign material, the Nugent #1R Duplex fuel oil filter is a direct aid in the efficient operation of this engine. By actual test on other engines, Nugent filters remove particules as small as a few microns that other wise might block the fuel injector or accelerate wear and tear on the engine.

Nugent #1R Duplex Fuel Oil Filter

Wherever engines must give long, dependable service, Nugent filtering provides the type of protection that is essential. That's why Nugent filters are factory installed on so many leading diesel engines.

Offering more effective filtering at lower cost, Nugent filters are available in a complete range of sizes and types to meet every need. They utilize inexpensive bag type cartridges having 20 times the filtering area of other filters of comparable size. And remember, Nugent filtering means 99.8% clean oil.

Write for descriptive bulletin.
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OIL FILTERS, OILING AND FILTERING SYSTEMS, LUBRICATING
OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS
Established 1897

All-Purpose Shaft Seal

A new all-purpose mechanical seal has been announced by the Crane Packing Co., 1800 Cuyler Ave., Chicago 13, Ill. Known as "John Crane" type 19, the seal is said to provide life-time performance in small pumps, hot water circulators, and many other rotary shaft applications.

Special beveled cones made of Teflon are utilized as the flexible member. This adapts the seal for services involving water, oil, corrosives, or acids; temperatures from —100°F to +450°F; vacuums and pressures to 200 psi; and high shaft speeds.

New Recirculating Valve

A recirculating valve that may be used for any stream dividing application of gases, air, salt water, oil, and mild chemicals up to 125 psi is now in production by the Ardee Mfg. Co., 840 No. Seward St., Los Angeles 38, Cal. The design incorporates a combination of plug valve principles and O-ring sealing.

Manufacturer claims that positive leakproof condition is obtained and that handle loads and internal wear are reduced to minimum by use of an externally adjustable spring seating control featuring multiple ball pressure contact against a hardened wear ring. It is available in cast aluminum, steel, or Navy bronze, with bronze and steel valves cadmium plated throughout. Flange connections may be had for either male or female thread adaptation.

New Electrode Holder

A new 400-amp insulated electrode holder, the Cooltong, has been announced by the Lincoln Electric Co., 22801 St. Clair Ave., Cleveland 17, Ohio. It is claimed that in one test made with the holder, it remained cool enough to weld with bare hands when using 400-amp current.

The nose is a special construction of a copper core between four and six layers of laminated, glass impregnated plastic cloth. The jaws, covered by the insulating construction, are made of Mallory 3 metal, non-spatter type, and will handle electrodes from 1/8- to 5/16-in in size. The holder

handle, perforated with large holes for ventilation and to reduce heat from induced currents when welding AC, is unbreakable and easy to hold in any position.

Repair of Truck Batteries

Gould-National Batteries, Inc., Trenton 7, N. J., has developed a simple mold for repairing industrial truck batteries with which connectors can be spliced directly on the job. After inter-cell connectors have been sawed, battery elements removed for repair, and the repaired cell replaced in its rubber jar, the mold permits reconstruction of the sawed connector in its original form.

The mold consists of a plate with two side blocks, one fixed and the other movable. Before it is placed

under connector to be spliced, the two sawed ends of the connector are chamfered to provide puddling space. It is then supported from both sides by small wedges. The movable block is next brought into contact with the connector. It is then possible to use the lead-burning electrode to make the weld in the exact shape and form of the original connector.

GM Introduces New Truck

The Truck and Coach Div. of General Motors Corp., Pontiac 11, Mich., has added model D660-47 to its diesel truck line in the heavy duty field. It features the 4-71 diesel engine furnishing power through the 5553A syncromesh transmission with over-drive and Eaton 19501 2-speed axle.

The model is available in 141, 153 and 165 wheelbases with CA dimensions of 60, 72 and 84 in—all for tractor service. A new radiator features a high-mounted filler neck for greater

(*Continued on page* 109)

All Metal THERMOMETERS

with WESTON dependability built-in

The heart of the modern, dial-type thermometer is the all-metal temperature element. Developed over 15 years ago, the WESTON all-metal element has plenty of proof behind it. In fact, the dependable accuracy of this unit has made the readable WESTON thermometer favorite for laboratory use as well as for all industrial temperature needs. For *extra* dependability, specify WESTON all-metal thermometers . . . available in the types, ranges and sizes indicated below. Literature available. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.

Type	Scale Length	Ranges		Stem Length		% Accuracy of Thermo. Range
		As low as	As high as	As short as	As long as	
Heavy Duty Straight Form	9"	−100F	+1000F	2½"	48"	1
Heavy Duty Angle Form	9 or 12"	−100F	+1000F	2½"	72"	1
Standard Angle Form	6"	−100F	+1000F	2½"	72"	1
General Purpose	4½"	−100F	+1000F	2½"	36"	1
Laboratory	3.40"	−100F	+500F	2"	24"	½ of 1

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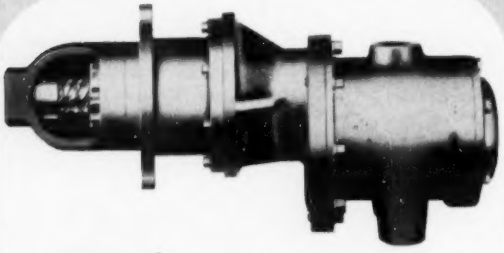
NO MORE BATTERIES
TO WORRY ABOUT!



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Air STARTING MOTORS
give you trouble-free
Engine Starts!

RELIABLE—Whatever the weather, I-R Air Starting Motors are built to give you ample power for fast, sure engine starting—anywhere.

LOW COST—No batteries, generators or electrical parts to buy or replace . . . and practically no maintenance expense.

COMPACT—These lightweight I-R Air Starting Motors are small (as little as 13" long) but *powerful*. They are available for all popular gasoline and diesel engine sizes.

EASILY INSTALLED—Mounting I-R Air Starting Motors is no problem to any mechanic. They're designed for quick installation and minimum maintenance.

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911-18A

Ingersoll-Rand

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N. Y. Central Investigates . . . .

(Continued from page 72)

1952. Equipment for this installation was as follows:

1. Speed recorders equipped with magnetically operated pencils driven by each power axle.

2. Metal cabinets installed to enclose the two panel boards containing the relays and equipment.

3. Specially adjusted through cable type relays installed in place of the old style relays for permanent operation.

4. A special vapor relay used as a series wheel slip relay.

5. A vapor type interlock assembly installed on each motor shunting contactor.

6. A potential relay (known as OSR) designed to pick up in parallel shunt at main generator output of 950 v. Trouble was experienced with OSR relays picking up at voltages considerably lower than that for which the relay was set. A thorough investigation indicated that engine room vibration was causing this undesired action. A more reliable relay was installed to obtain the desired function.

The purpose of the OSR potential relay is to prevent runaway in the event that both power wheels driven by one main generator slip simultaneously. Under this condition main generator output voltage rises rapidly and if power contractors are not in a parallel shunt position, transition to that position will take place. An interlock on the shunting contactor brings in the OSR relay across main generator at 950 v which corresponds to approximately 105 mph wheel speed. The OSR picking up causes battery and shunt field contactors to drop out, unloading the power plant and preventing any higher speed operation of the traction motors.

The test of this high speed wheel slip arrangement is being watched and analyzed carefully, but complete data on its performance is not yet available due to the relatively short time it has been in operation.

Summary

Generally speaking, a few statements concerning results of this extended investigation may be made—some of these points were included in a report in the latter part of 1951 and have been reaffirmed since. (1) Existing wheel slip relays furnished with the locomotives when purchased, do not afford complete protection against locomotive driving wheel slipping; (2) Speeds obtained during slippage often exceeded by as much as 50 per cent—the limit recommended from a standpoint of stress on equipment; (3) spinning of diesel wheels occurs on trailing units as frequently as on lead units, if not more often; (4) Engineman is often unaware of slip because of absence of wheel slip light indication; (5) Wheel slippage occurred on all parts of the railroad, weather influence on rail condition is a contributing factor; (6) It is believed that considerable saving in damages to equipment and a reduction in road failures can be realized by providing the engineman with reliable indication of wheel behavior under all conditions.

water reserve and wider safety margin. A capillary-type temperature gauge is standard. A new engine warning device sounds an alarm buzzer in time for the driver to head off damage.

New Hard-Facing Alloy

Coast Metals, Inc., Little Ferry, N. J., is manufacturing a new hard-facing alloy, CM-199, said to have high resistance to abrasion at high temperatures and ability to withstand attack by molten copper.

The alloy, applied with the arc welding process, will weld over itself and more ferrous materials without "cracking, checking or parasity, permitting patching where previously full replacement had been necessary."

Industrial First Aid Unit

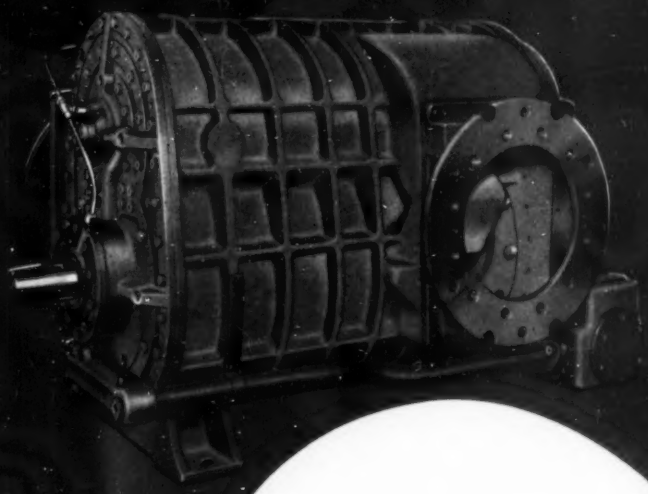
General Scientific Equipment Co., 2700 W. Huntington St., Philadelphia 32, Pa., is making available a magnetic eye sweep, a handy instrument for industrial first aid especially where workers are exposed to flying metallic fragments.

One end of the instrument is fitted with a magnet, while the other has a flexible loop for removing cinders, dust, and other particles. Sterilization of the instrument is said not to diminish the magnetic qualities nor affect the loop. A hard rubber carrying case is provided with each sweep.

Fire-Retardant Laminate

A flame-retardant laminated plastic with consistently low 60-cycle power factor has been announced by the Chemical Div. of the General Electric Co., Pittsfield, Mass. Designated GE 11537 Textolite, the paper base laminate has application for switchgear, control equipment, etc., where

STANDARDAIRE BLOWERS



move more air
with less wear—
less maintenance
and power costs
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OF EQUAL WEIGHT, SIZE
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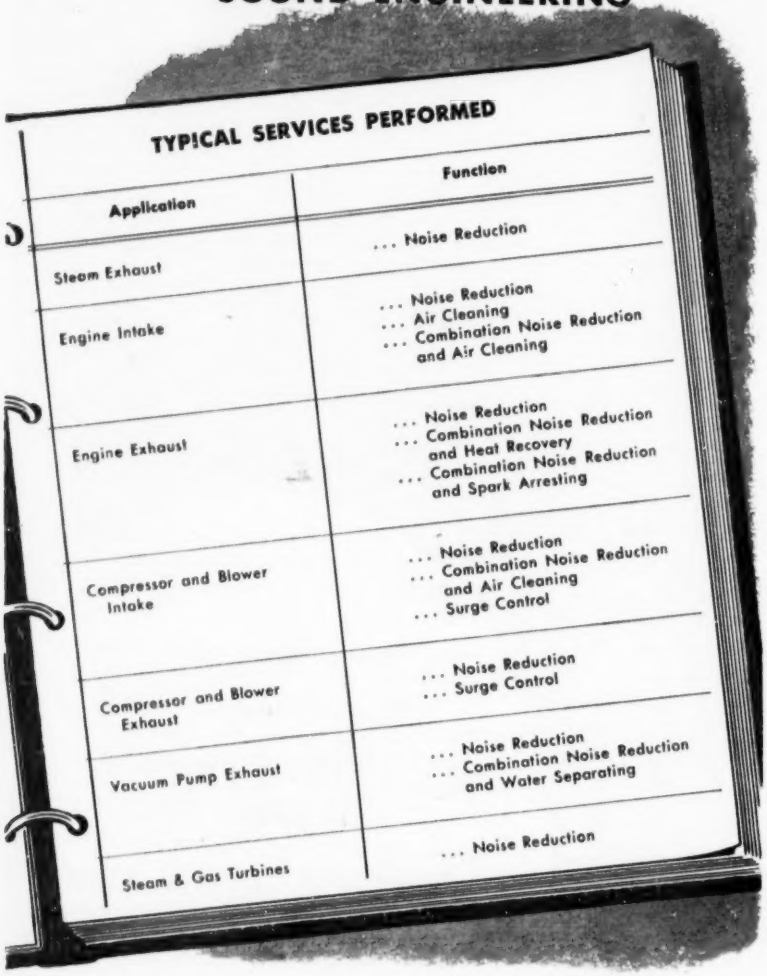

TYPICAL SERVICES PERFORMED

Application	Function
Steam Exhaust	... Noise Reduction
Engine Intake	... Noise Reduction ... Air Cleaning ... Combination Noise Reduction and Air Cleaning
Engine Exhaust	... Noise Reduction ... Combination Noise Reduction and Heat Recovery ... Combination Noise Reduction and Spark Arresting
Compressor and Blower Intake	... Noise Reduction ... Combination Noise Reduction and Air Cleaning ... Surge Control
Compressor and Blower Exhaust	... Noise Reduction ... Surge Control
Vacuum Pump Exhaust	... Noise Reduction ... Combination Noise Reduction and Water Separating
Steam & Gas Turbines	... Noise Reduction

Our extensive line of standard and special noise attenuating SNUBBERS and silencers permits us to recommend the most suitable units for your particular application.

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fire hazards exist and the mechanical and insulating properties of laminates are needed. It will burn only at elevated temperatures and is self-extinguishing in 1 min or less.

The new grade has good cold flow characteristics, low moisture absorption, and retains its electrical properties at temperatures up to 125 C. All thicknesses can be machined as well as conventional laminates. Sheets up to ⅛-in thick have good punching quality. It is available in sheets from .010- to 2.0-in thick.

New Exide Batteries

Twenty per cent more capacity in the same space is the advantage claimed for the new line of T-H Exide Ironclad batteries just announced by The Electric Storage Battery Co., Box 8109, Philadelphia 1, Pa. The new battery now incorporates polyethylene non-oxidizing slotted plastic tubes to keep the active material in constant contact with grid spines and still permit free electrolyte penetration throughout the active material. An added feature is the polyethylene acid-proof tube-sealer fitted to the bottom of the positive plate to seal in the active material. Grids contain Silvium, contributing to longer battery life.

Positive plates are larger and are balanced by extra-heavy negative plates. Pormax separators, homogenized sealing compound, and seamless rubber jars contribute to performance. Steel trays are sprayed with plastic coating and new quarter-turn plastic vent plugs facilitate easy servicing with water.

Slide Seal Coupling

Aeroquip Corp., Jackson, Mich., has developed a new slide seal coupling which permits instant connection and disconnection of fluid-carrying lines by means of a simple push-pull action it was announced. Motion is similar to that used when inserting and removing a plug from an electrical outlet.

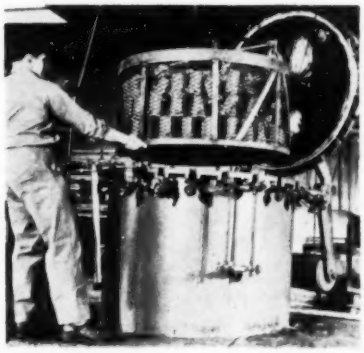
The coupling consists of two 2-piece die-cast aluminum assemblies with rubber "O" rings. A spring actuated locking device holds each half in the coupled position to permit full

flow of fluids. Pressing the lock lever separates the halves and starts the disconnecting action which is completed by a light pull. When fully disconnected, each half forms a perfect seal. Reconnection may be accomplished without actuating the lock lever.

Sealing of Porous Castings

A system of sealing porous castings has been developed by American Metaseal Mfg. Corp., 30 E. 60 St., New York 22, N. Y. Heart of the system is a self-contained unit comprising autoclaves, high-vacuum pump, thermostatically controlled wash tanks, a mechanical surging unit, and a power-operated hoist. One hundred per cent filling of micropores is claimed.

The machine, designed for one-man operation, is built around a center unit containing the activating cylinders. This hub unit mechanizes all



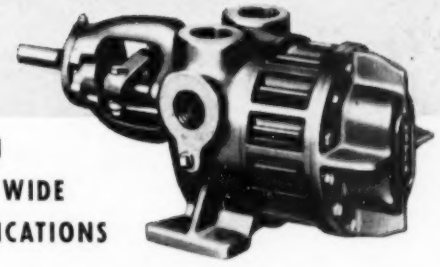
functions from basket loading through the vacuum pressure cycle and the cleaning surge. Built on its own platform it can be placed anywhere and comes equipped with valves, gauges and piping.

The sealant is a resin in monomer form, polymerizing after heating, and is removed from surfaces by emulsification after the immersion cycle. It is claimed stable with all alloys including copper-base materials, is said to be resistant to a wide range of chemicals, and can be applied to any product that requires sealing against liquids and gases as well as protection against corrosive agents.

New Power Control Unit

The Baker Mfg. Co., Springfield, Ill., announces the PCU-75, a new power control unit which combines a

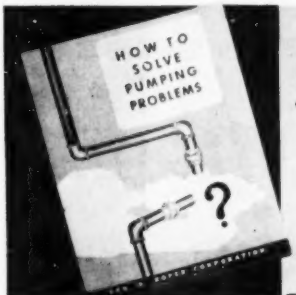
Install
ROPER
ROTARY PUMPS
for Positive Results



MODELS FOR AN EXCEPTIONALLY WIDE RANGE OF APPLICATIONS

SERIES F PUMP

SERIES	TYPICAL USES	PRESSURES	SIZES
3600	All Petroleum Handling Grease Compounding Oil Circulating General Transfer	to 60 P.S.I.	40-300 G.P.M.
F	Pressure Lubrication Hydraulic Power Fuel Transfer Lube Oil Transfer	to 300 P.S.I.	1-300 G.P.M.
K	Pressure Lubrication Hydraulic Service Industrial Oil Burner Fuel Supply	to 150 P.S.I.	¼-50 G.P.M.
H	Hydraulic Power Test Equipment Pressure Lubrication High Pressure Coolant	to 1000 P.S.I.	5-75 G.P.M.



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ROPER Rotary Pumps

multiple disc clutch with a simplified brake design. The clutch can be engaged or disengaged with a 5-in lever travel. The brake system features single point adjustment with tension changes from one adjusting bolt.

Horizontal swing-action hand levers may be adjusted for length, angular position and height. Sheave frames are mounted on roller bearings for even cable winding, and sheaves are on hardened pins with roller bearings. Clutches are covered. Line speeds reach 710 fpm with full drum at 1700 rpm; capacity is 225 ft of ½-in diam cable.

The PCU-75 is designed for use on HD-15 and HD-20 Allis-Chalmers tractors and others of similar capacity.

Spacer Type Gear Coupling

A new spacer type gear coupling which can be disconnected in a short time without wrenches or special tools, is announced by the Sier-Bath Gear & Pump Co., Inc. 9252 Hudson Blvd., North Bergen, N. J.

The new coupling consists of flexible hubs on both driver and driven shafts. Center unit, or spacer, has teeth at either end cut so that they mate with each sleeve in a spline fit. Connections have no angular or offset flexibility, but allow for end-float. The two sleeves connect the driver and driven units through the spacer.

Micro-Moly — New Lubricant

A series of lubricants, consisting of molybdenum disulfide in a variety of carriers, is being marketed by Hill Dale Industries, Inc., 1365 W. Farms Rd., New York 59, N. Y. The value of molybdenum disulfide as a solid-film lubricant is currently gaining much attention.

The company stresses two properties claimed for their product which they believe to be of extreme importance. They guarantee purity to be not less than 99.3 per cent. The importance of this lies in the fact that the impurities not removed during the refining process consist of iron oxides and silica materials, both of which are very abrasive.

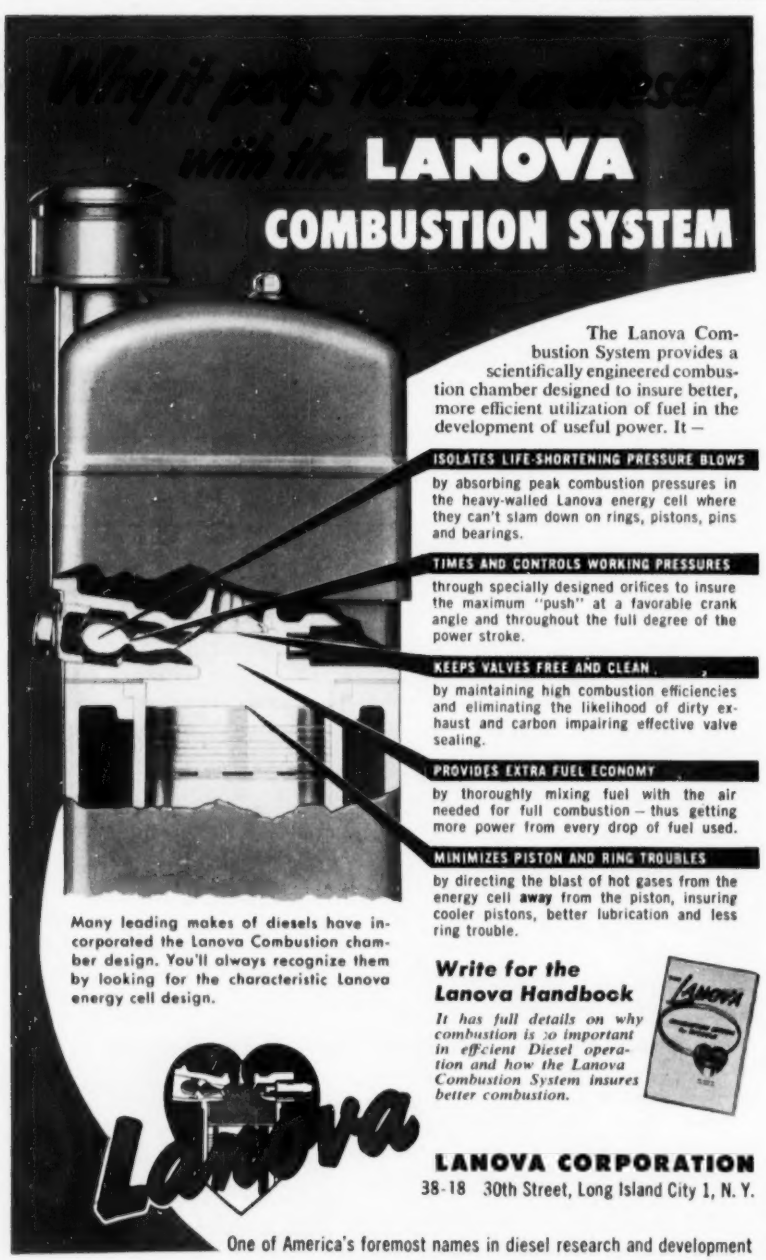
The second point concerns particle size. They claim 95 per cent of the particles to be one micron in size and the other 5 per cent, less than three microns. This is held important as it permits the particles to pass through the average filter.

Other qualities of the molybdenum disulfide material are: excellent chemical and thermal stability (up to 750°F); high film strength; low coefficient of friction at extreme pressures; tenacious adherence; and nonmagnetic as well as dielectric properties.

New Rotary Broach

Shearcut Tool Co., 7045 Darby Ave., Reseda, Cal., has introduced an improved version of its rotary broach to produce perfect holes. Holes may now be finished to an accuracy of + or —.0001, and the final surface finish produced will generally be from 10 to 40 R.M.S.

The tool removes metal by a shearcutting action which forces the chip being removed ahead of the tool, eliminating any chance of the chip scarring the hole being finished. The tool is made with high spiral or heli-


Why it pays to buy a diesel with the LANOVA COMBUSTION SYSTEM
The Lanova Combustion System provides a scientifically engineered combustion chamber designed to insure better, more efficient utilization of fuel in the development of useful power. It –
ISOLATES LIFE-SHORTENING PRESSURE BLOWS
by absorbing peak combustion pressures in the heavy-walled Lanova energy cell where they can't slam down on rings, pistons, pins and bearings.
TIMES AND CONTROLS WORKING PRESSURES
through specially designed orifices to insure the maximum "push" at a favorable crank angle and throughout the full degree of the power stroke.
KEEPS VALVES FREE AND CLEAN
by maintaining high combustion efficiencies and eliminating the likelihood of dirty exhaust and carbon impairing effective valve sealing.
PROVIDES EXTRA FUEL ECONOMY
by thoroughly mixing fuel with the air needed for full combustion – thus getting more power from every drop of fuel used.
MINIMIZES PISTON AND RING TROUBLES
by directing the blast of hot gases from the energy cell away from the piston, insuring cooler pistons, better lubrication and less ring trouble.
Many leading makes of diesels have incorporated the Lanova Combustion chamber design. You'll always recognize them by looking for the characteristic Lanova energy cell design.
Write for the Lanova Handbook
It has full details on why combustion is so important in efficient Diesel operation and how the Lanova Combustion System insures better combustion.
LANOVA CORPORATION
38-18 30th Street, Long Island City 1, N. Y.
One of America's foremost names in diesel research and development

cal cutting flutes, sharpened on the ends. When pressure is applied it produces chips which resemble steel wool in appearance and texture. It may be used to finish holes which have previously had keyways or splines formed in them.

TOCCO Cylinder Bore Hardening

A new development in the field of TOCCO induction hardening is announced by the Ohio Crankshaft Co., 3800 Harvard Ave., Cleveland 5, Ohio. It makes possible the induction-hardening of cylinder bores of conventional, cylinder-iron castings.

Blocks are reportedly easy to machine although the surface of the cylinder bores are very hard to a depth of 1/16 in. This depth of hardness permits several re-honings with no loss of hardness in the bore.

The company feels that this is an economical solution to the problem of obtaining long bore life without resort to various hard alloy irons that are frequently difficult and expensive to cast and machine. In some cases, it will obviate the necessity for cylinder liners that have been adopted as a solution to this problem.

It is estimated that the cost of hardening the bores would be less than half the extra cost of alloy-iron cylinder blocks. It would also be less expensive than liners and would reduce the space required for such installations.

New Cemented Carbide Alloy

Kennametal, Inc., 700 Lloyd Ave., Latrobe, Pa., is reported to have developed a new alloy trade-named "Kentanium", which is composed preponderantly of titanium carbide with small percentages of tantalum and columbian carbides, using nickel as a binder.

According to the producers, the alloy resists oxidation at 1600°F-1800°F, far better than tungsten carbide materials, and its density is only about ½ to 1/3 as great. Its hardness is very high (Rockwell A 83/93) and is retained to considerable extent at elevated temperatures, the same being true of its compressive strength. Its elastic modulus is about twice that of steel.

Non-Glare Shields

Flexible non-glare shields are being produced by Filterzone Auto-Vision Co., 641 Lexington Ave., Brooklyn 21, N. Y. They are simple to mount, stick to glass on contact, and can be removed at will.

The shields are made of flexible Vinyl plastic that won't crack and is washable. They have found use on locomotives as well as other applications. A variety of colors is available.

New Strippable Coating

Development of a protective, strippable coating has been announced by Eagle Chemical Co., Joliet, Ill. Called "spray-strip", the product is capable of cold application by spray, brush or dip method and may be applied to either metallic or wood surfaces. Fast-drying qualities are claimed—it is said the product will set in 20 min after application — and it is also claimed impervious to greases, oils and lacquers.

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L-N GENERATORS are proving their superiority over conventional standard equipment on thousands of jobs. For 6 and 12 volt systems. High output, long life, reliable performance.

L-N CRANKING MOTORS

High torque, fast cranking speed guarantee quick starts even with cold, stiff engine. For 12 volt and 12-24 volt series-parallel systems. Also higher voltages.

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For short runs, long idling, heavy current needs, nothing equals the L-N AC-DC Alternator System. 25 to 35 amps idling! To 80 amps for 6 volt systems; to 175 amps for 12 volt. Also higher voltages.

★ *Now producing cranking motors, generating systems, pump motors and special equipment for military engines.*

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HEAVY-DUTY ELECTRIC EQUIPMENT FOR OVER 43 YEARS

TRUCK BUS DIESEL OFF-HIGHWAY

PASSENGER RAILROAD MARINE INDUSTRIAL

Piston Resizing Machine

Latest product of Wilkening Mfg. Co., Philadelphia 42, Pa., is the Pedrick Kam-Kurl, a precision machine for expanding piston cam diam and producing a notched or knurled surface on the thrust faces of the piston skirt. It accomplishes this by swaging between two roller knurls, one on the outside of the piston and the other acting as a roller anvil on the inside of the piston.

Surface of roller anvil is serrated to keep piston from slipping during operation. Amount of knurling is controlled by air pressure. A heavy-duty chuck holds pistons from 2- to 6-in diam. According to the company, worn and collapsed pistons may be expanded permanently to original size or beyond, at either end of the skirt or evenly along its full length. Also, oil reservoirs, created on the thrust faces of piston skirt by the process, trap and hold oil which lubricates instantly during cold starts and idling. Knurls are available in diagonal parallel lines or cross-hatch diamond.

New Literature

Transmission Systems

Fischer & Porter Co., 7250 Jacksonville Rd., Hatboro, Pa., is releasing catalog T-50 describing pneumatic, magnetic, electric, electronic and electronic-follower transmission systems for use in measurement and control of flow, pressure, liquid level, viscosity, and specific gravity. The catalog is illustrated and contains performance characteristics and schematic diagrams of the various systems.

Millivoltmeter Instruments

Millivoltmeter type instruments—indicating, electronic control, and safety shut-off—are described and illustrated in catalog 1053 issued by Brown Instruments Div. of the Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Information on operating and applications of on-off, 2-position, 3-position, and "pulse type" time-proportioning controllers is included, as well as data on primary measuring elements, dimensions, ordering information and scale selection tables.

Oil & Gas Engine Power Costs

The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y., has just published its "Report on Oil and Gas Engine Power Costs for 1951", based upon latest available material.

The report includes information from 123 oil, dual-fuel, and gas engine generating plants containing 470 engines, totaling 500,370.5 rated bhp, total net output of which amounted to 808,231,227 kwhr. Tabular listings give information on production costs, comparative costs from 1929 on, and engine details and operating information. Production cost as relating to plants, consists of fuel cost, lubrication cost, cost of attendance and superintendence, cost of supplies and miscellaneous, cost of engine and all other plant repairs.

The report sells for $2.50 per copy with bulk discounts available.

In the Field of Diesel Power

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The Nation's Largest Distributor of GM Diesel Engines

Nordberg Duafuel Engines

Publication of a 3-color, 16-page bulletin (No. 202) on the design, construction, operation and application of its 2-cycle Duafuel engines is announced by Nordberg Mfg. Co., Milwaukee 1, Wis.

The engines described are built with either high or low pressure fuel injection systems to meet specific operating conditions. They are built in 29-in, 21½-in, and 17½-in cylinder bore sizes and are designed to burn gas plus pilot oil, fuel oil only, or intermediate proportions of either fuel.

Design features are discussed, including descriptive data on the pilot oil injection system, hydraulically actuated gas valves, forced feed lubrication, and positive action safety devices. Typical engine installation views are given and sectional views and assembly pictures illustrate the pertinent features. In addition, a schematic diagram shows the starting air, fuel oil and gas systems.

Instrument Gauges Bulletin

A 24-page bulletin (No. 98214) has been released by Taylor Instruments Companies, 95 Ames St., Rochester 1, N. Y. It describes their latest development in 6-in dial indicators for temperature, pressure and load applications. Illustrations and information on features, dials and scales available, together with reference material on different types of actuation are given.

For temperature instruments, a variety of sensitive elements or bulbs are explained with recommended applications for each. Mounted dimensions for the different types of instruments are also included to give a clear picture to the prospective user.

Air Control Valves

A 12-page, illustrated booklet explaining the characteristics of air power and describing three fundamental types of air control valves has been released by the Ross Operating Valve Co., 120 E. Golden Gate Ave., Detroit 3, Mich.

Colored diagrammatic drawings show how air flows through the valves to the operated cylinders. Advantages of each type, an explanation of how they work, and a list of available standard models are included.

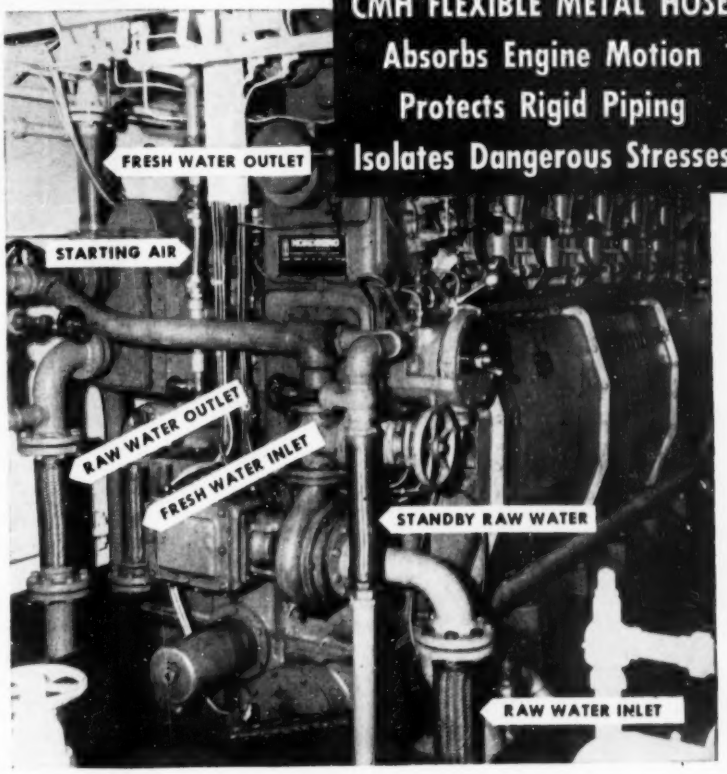
Operator's Handbook

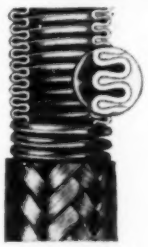
Caterpillar Tractor Co., Peoria 8, Ill., has issued another cartoon-type handbook giving operating instructions for its cable and hydraulic shovels. Differences between the two are explained and demonstrations are given for excavating and backfilling operations.

Nickel Cadmium Batteries

A 4-page bulletin describing the engine starting characteristics of nickel cadmium batteries has been issued by the Nickel Cadmium Battery Corp., 100 Park Ave., New York 17, N. Y. Principles behind the "low-internal-resistance and self-discharge qualities" of the batteries are discussed and a comprehensive list of specifications to be used in determining battery needs of all diesel industrial engines is given.

CMH FLEXIBLE METAL HOSE
Absorbs Engine Motion
Protects Rigid Piping
Isolates Dangerous Stresses





Vital piping connected to the Nordberg marine diesel shown above, is protected with CMH Flexible Metal Hose. The stresses of vibration, expansion and contraction, and misalignment are effectively absorbed by these flexible connections. In existing installations or new ones, it will pay you to eliminate these common causes of piping failure with CMH Flexible Metal Hose. Write for Bulletin 124.

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Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.
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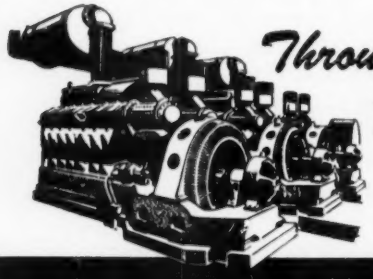
There is a competent Aerofin heat-transfer engineer near you—qualified by intensive training and long experience to find the *right* answer to your own particular heat-exchange problem—and backed by the research and production facilities of the pioneers in light-weight extended surface.

Ask the Aerofin Man.



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Aerofin is sold only by manufacturers of nationally advertised fan system apparatus. List on request.

Microcast Movie

Austenal Laboratories, Inc., 5932 So. Wentworth Ave., Chicago 21, Ill. has issued a folder giving information on its new 16-mm color motion picture entitled: "Microcast, A Story of Industrial Progress." The film explains the development and uses of the microcast process of precision investment casting.

Cylinder Liner Deterioration

The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y., has released an 8-page illustrated report entitled "Water Side Deterioration of Diesel Engine Cylinder Liners." The paper deals with problems in water cooling of diesel engines, especially a "dynamic" pitting encountered in various services: railroad, highway trucks, tractors, marine and cross-country gas line compressor stations.

Important factors involved are: dissimilar metals, design, concentration cells at juncture of liners with engine block, variable velocities and temperatures, composition of liner and cooling water and occasional rapid localized pitting, apparently of dynamic origin. Ordinary corrosion, it is said, can be controlled in the closed water cooling system by using chromate or other water-soluble inhibitors in soft water low in organic matter.

The "dynamic" pitting referred to is less common but is revealed to be often much more rapid than any electro-chemical pitting of cast iron. This type of pitting is illustrated and described in detail. Reasons are given for failure of protective measures to stand up in service and certain steps are outlined that are expected to provide effective remedies.

Resistance Welding Catalog

A 24-page catalog on resistance welding has been released by Ampco Metal, Inc., 1745 So. 38th St., Milwaukee 46, Wis. Full information on the company's line is given including the newly designed tips and holders which have recently been added. Reference tables and comparative charts giving physical properties, applications, and R.W.M.A. specification data are also included.

(*Continued on page* 118)

Two Years with Bunker "C" Fuel

(*Concluded from page 60*)

Another pump takes fuel from the make-up tank to replenish what the engines burn from the circulating loop. Excess fuel from this pump is bypassed back to the make-up tank through a relief valve set at 20 psi. Thus the intake of the circulating pump and low pressure header are maintained at 20 psi. The pressure in the high pressure header, after the drop through the filters, is maintained 20 psi higher by the action of the relief valve in the circulating loop.

A problem encountered with this system concerned the equable division of flow to the different engines. This same problem was encountered earlier in balancing flow among the centrifuges. When these were first installed, gate valves were installed to divide the flow from the steam heat exchanger ahead of the centrifuges. Difficulty was encountered at once. No matter how carefully the valves were set, the operator was forced to reset them in a few minutes to re-balance the flow. Special metering valves of the tapered plug type were tried with no improvement.

This problem was solved by holding a constant pressure on the centrifuge inlet by means of a pressure-regulating valve. These were arranged with wing nuts so that the operator could adjust the pressure and consequently the flow.

The principle of control by holding constant pressure against an orifice was used in the return part of the engine loop. The regulating valves permit adjustment of the effective orifice so as to obtain enough flow to keep the fuel hot and circulating, as well as keeping a constant pressure on the inlet of the high pressure fuel injection pump.

This continuous circulation system has been in operation for nearly a year and has given no trouble. There is so little fuel in the circulating loop that at light plant loads it is consumed in about an hour. At full plant load it takes only a few minutes.

Light Oil Percentages

Question naturally comes up as to how much light fuel is actually admitted by the check valve. For four consecutive months, it averaged less than 8 per cent of the total fuel burned. This figure includes fuel used in the steam boiler, fuel for starting and stopping, and what little is used for cleaning.

When extensive rearrangements were made in the heavy fuel system, the percentage of light oil used jumped to 20.3 per cent. A graph is kept of the percentage used and prominently displayed. Thus, any rise not due to planned outage of the heavy fuel system, or to running an engine on light fuel after overhaul is evident. Not only can this be used to check correct starting or stopping operations but is is also a check that the heavy fuel system is functioning correctly.

HILCO LUBE and FUEL OIL PURIFICATION

Get Rid of Dirty Oil . . .
Get Lower Operating Costs,
Longer Equipment Life

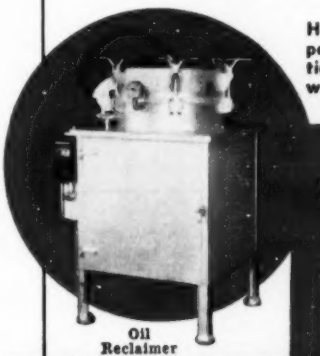
HILCO oil purification means complete oil purification! With a HILCO you get removal of sludge, acids, carbon, water and fuel dilution economically and efficiently. HILCO operation is continuous, all-electric and automatic.

Clean oil at all time reduces down time, increases production and HILCO units pay for themselves in savings.

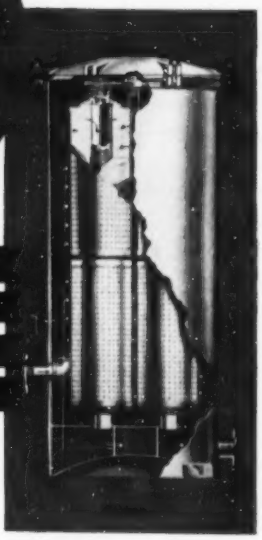
HILCO offers a wide range of oil purification units . . . one to meet your needs. Write us about your equipment . . . and get recommendations at no obligation.

• THERE'S A HILCO FOR EVERY LUBRICATION AND FUEL OIL FILTERING PROBLEM

HILCO has 25 years experience in oil purification. Let this experience work for you.



Oil Reclaimer



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Brochure on Gas Meters

A 16-page booklet on meters for measuring gases of any type, and in quantities from 4000 to 1,000,000 cu ft, has been published by Roots-Connersville Blower Div. of Dresser Industries, Inc., Connersville, Ind.

In addition to detailed descriptions and illustrations of meters of various types, the booklet contains a selection table to determine the meter required for any load, whether at standard or variable conditions of temperature and pressure.

Railroad Telephone Network

Application of a railroad-owned, long-distance telephone network in the administration and operation of the Louisville & Nashville Railroad is presented in an illustrated 12-page case history published by Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill. Specific use and economies are discussed in detail and general specifications of telephone equipment are listed and illustrated.

Mercury Flow Type Meter

Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia 42, Pa., has prepared a 20-page bulletin describing its type H-meter, for the measurement of water, gas, air, sewage, sludge and other industrial liquors. Facts on the unit's operation, construction, sizes and capacities, and specifications are listed.

Recorder Controller Bulletin

A 16-page illustrated bulletin just issued by The Foxboro Co., Foxboro, Mass., describes its restyled circular case controller, an instrument to automatically control temperature, pressure, liquid level or other process variables.

A section of installation diagrams and text is devoted to on-off and proportional control, explaining proper selection of controller action to match demands of a process. Another section analyzes the four classes of measuring systems available for automatic temperature control. Measuring elements are included.

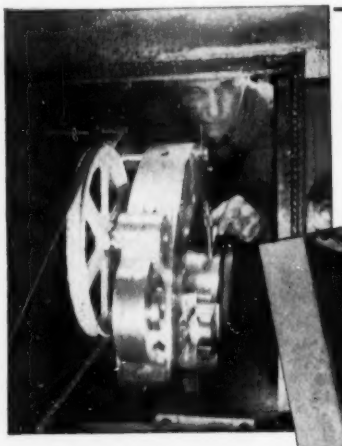
Penn RR Reviews Progress

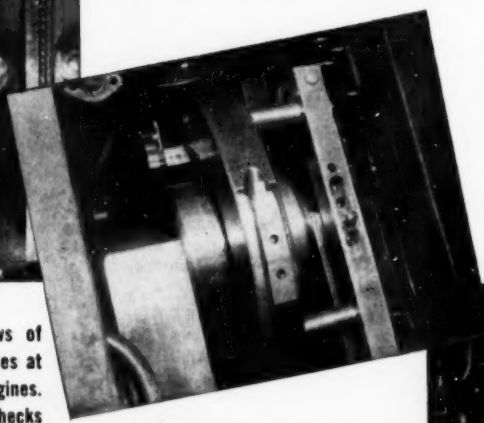
The Pennsylvania Railroad Co., Philadelphia 4, Pa., has published a pictorial review of the progress in its development. During 1952, 246 new diesel-electric locomotives were placed in service, adding 333 units and over 500,000 hp to the road's diesel power. At the close of the year 1330 diesel-electric locomotives were owned comprising 1888 units with a combined hp of 2,588,570, making it the largest owner of diesel power. Photographs of new facilities, maintenance equipment, and mechanization advances are included.

Pressure Regulating Valves

The Swarthout Co., 18511 Euclid Ave., Cleveland, Ohio, announces a new 12-page bulletin on its line of pressure regulating valves and pressure master controls.

Printed in two colors and punched to fit 3-ring binders, the catalog is illustrated with photographs, cutaways and section views, dimensional and specification data.





CRANK PINS REFINISHED IN PLACE

For engines of practically any size, several of our Portable Machines are available for quick and economical restoration of damaged crank pins. Let us help you minimize down-time.

Above illustrations show views of our Portable Crank Pin Machines at work in various size diesel engines. At left, a diesel engineer checks the accuracy of a refinished crank journal.

Additional information furnished without obligation

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Established 1876
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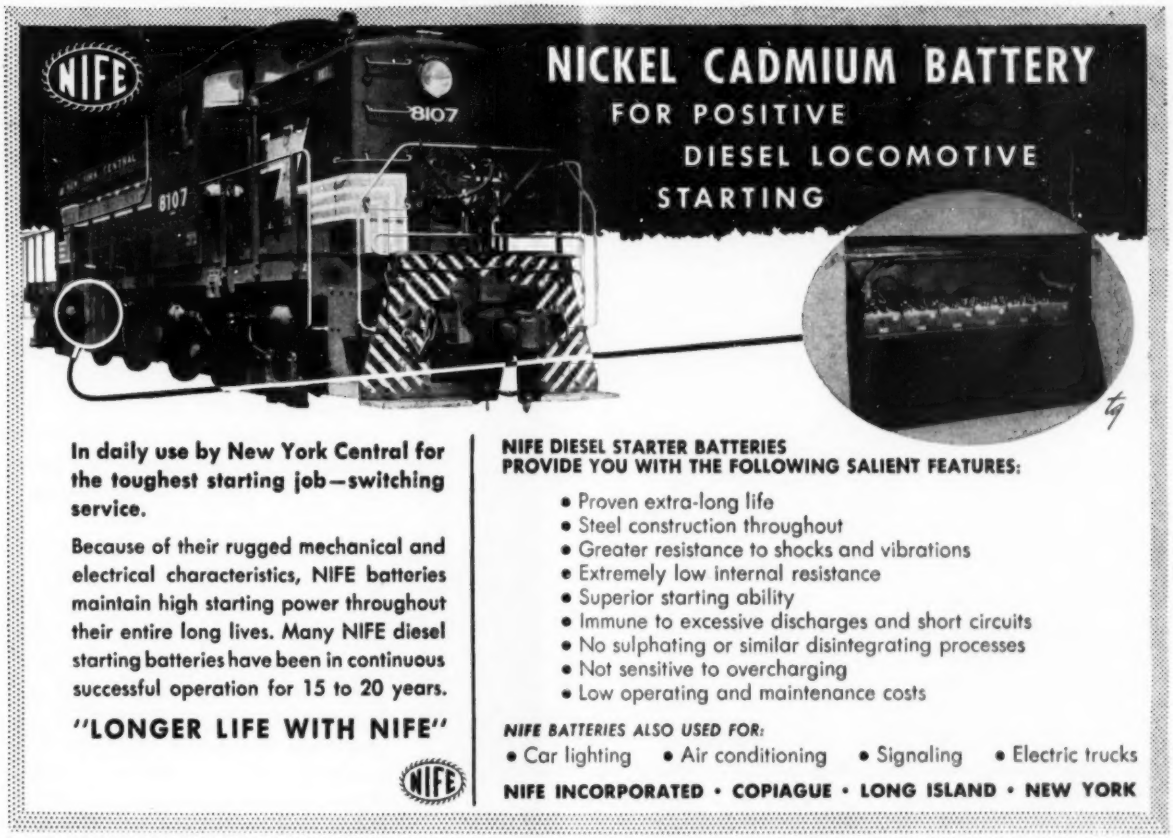
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DIESEL LOCOMOTIVE
STARTING
In daily use by New York Central for the toughest starting job—switching service.
Because of their rugged mechanical and electrical characteristics, NIFE batteries maintain high starting power throughout their entire long lives. Many NIFE diesel starting batteries have been in continuous successful operation for 15 to 20 years.
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PROVIDE YOU WITH THE FOLLOWING SALIENT FEATURES:
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NIFE BATTERIES ALSO USED FOR:
• Car lighting • Air conditioning • Signaling • Electric trucks
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Industrial Lubricants

A new booklet entitled "How to Simplify and Save with Pure Industrial Lubricants", has been issued by The Pure Oil Co., 35 S. Wacker Dr., Chicago 1, Ill. The booklet sets up six simple steps to streamline lubrication programs, and points out that for the average plant a maximum of six lubricants will do a satisfactory job.

Bolting for Pressure Piping

Taylor Forge & Pipe Works, P.O. Box 485, Chicago 90, Ill., is making available bulletin 524 on the subject "Modern Steel Bolting for Piping and Pressure Vessels." This was originally presented as a paper before the Seventh Annual American Society of Mechanical Engineers' Petroleum Division Conference in Kansas City.

Comments on each ASTM specification are given, plus tables on the compilation of properties and bolting selection. Also included is a discussion on the behavior of bolted flanged connections of the types used in piping and pressure vessels.

Truck Maintenance Manual

Designed as an an aid to economical salvage of truck and car equipment is a new manual, "Truck and Car Fleet Maintenance and Repair Welding Manual", offered by the Eutectic Welding Alloys Corp., 40-40 172nd St., Flushing, N. Y.

Step-by-step photographs, plus diagrams and charts in the 56-page book illustrate money-saving ways to add service life to automotive vehicles. Contents include repair of all stationary and operative parts grouped under these major headings: Salvaging Truck and Automotive Castings; Repairing Functional and Mechanical Parts; Saving Cracked and Damaged Body Parts; Salvaging Ornaments, Accessories and Auxiliary Equipment.

Stationary Diesel Engines

Burmeister & Wain, Ltd. of Copenhagen, Denmark, has issued a booklet describing its 4-stroke stationary engines. Specifications, longitudinal and cross sections, are given and mechanical parts are described.

Telemetering Booklet

The Bristol Co., Waterbury 20, Conn., has published a new booklet containing information on the use of its telemetering instruments for remote recording, indicating, and totalizing of electric variables over long distances.

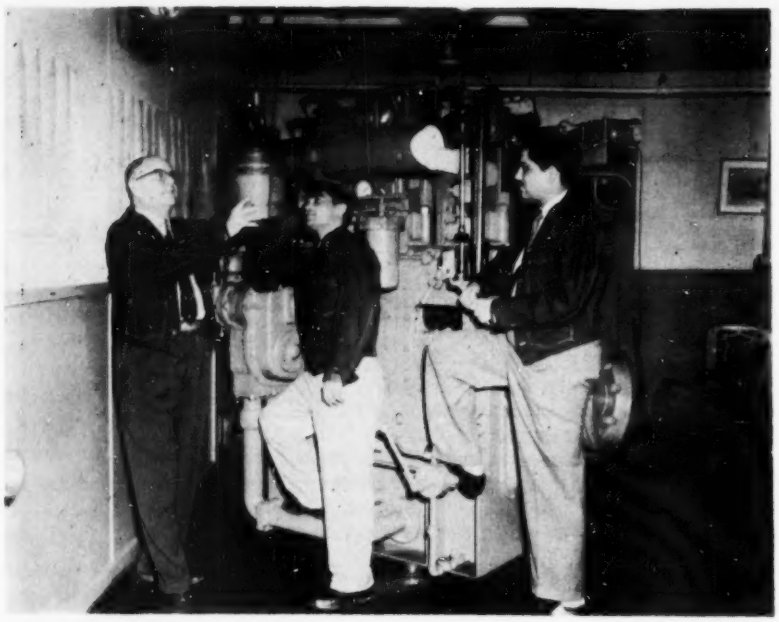
A number of typical installations in use at generating stations, on tie lines, and on dispatching boards are illustrated and described.

Silicone Rubber Bulletin

The properties and processing of silicone rubber as an insulating material for wire and cable are set forth in a new bulletin (No. CDS-13) issued by the Chemical Div. of General Electric Co., Pittsfield, Mass.

The bulletin is a reprint of a recent article written by M. G. Noble, a GE silicone engineer. Included is a description of processing, and property data is illustrated with charts and tables. A section on applications deals with the use of the material for ignition cable.

Field Notes



Pakistan Railway Engineers Study At Cooper-Bessemer

Two top-flight engineers of the Pakistan railways are currently attending a comprehensive diesel locomotive training and inspection program at the Cooper-Bessemer Corporation's plant in Grove City, Pennsylvania.

Besides making studies of manufacturing techniques and procedures, these men have the advantage of studying an actual full-scale cutaway of a 6-cyl supercharged engine, similar to 10 which are being furnished to power GE locomotives for the Pakistan Railway. Their training, under direction of Fletcher M. Devin, manager of C-B's Railway Engine Div., includes complete engineering background on efficient operation and maintenance of locomotive engines which they will eventually supervise.

In addition to furnishing diesel power for the 10 locomotives on this particular project, C-B already has its engines on numerous power shovels and draglines built by Bucyrus-Erie and Marion Power Shovel currently in operation in Pakistan. During their stay, Mr. Warris and Mr. Ansari will devote further study to engineering developments at Cooper-Bessemer's main plant at Mount Vernon, Ohio.

ASLE Meeting Held

The American Society of Lubrication Engineers held its 1953 Annual Meeting and Exhibit in Boston, April 13-15. Among papers presented were "Visual Analysis of Engine Sleeve Bearing Trouble" by E. C. Crankshaw and W. A. Weinkamer of the Cleveland Graphite Bronze Co., and "Mechanisms of Sleeve Bearing Failures" by P. B. Burgess of the Standard Oil Co. (Ind.).

Air Force Cans Engines

Cans made of 11- or 12-gauge low carbon, hot rolled steel plates are being used to ship airplanes overseas by the Air Force. The engine cans are air-tight, are in two sections, and flanged so that they can be bolted. Shock and vibration during shipping are eliminated. The cans are thoroughly protected so that dropping, rolling, or water immersion will not affect them.

NPC Investigation Reveals Synthetic Fuel Uneconomical

The National Petroleum Council recently completed a $500,000 study at the request of the Secretary of Interior, in which it concluded that Bureau of Mines proposals for the manufacture of synthetic fuel from coal and oil shale are "definitely uneconomical under present conditions" and that "the need for a synthetic liquid fuel industry in this country is still in the distant future."

It pointed out that when need arises for synthetic fuel, entirely new techniques, now unknown, may be available. The committee also disclosed that there is some likelihood of further reducing the cost of manufacturing liquid synthetic fuels by continued research in oil shale and Fischer-Tropsch processing of coal. "Coal hydrogenation on the other hand, requires drastic improvements in existing methods to permit economic operation."

The Bureau of Mines' work on synthetic fuels is principally concerned with three well-known methods: hydrogenation of coal, recovery and refining of oil from oil shale, and gasification of coal and conversion of the gas to liquid fuel by a Fischer-Tropsch process.

Santa Fe Pushes Dieselization

F. G. Gurley, president and chairman of the executive committee of the Atchison, Topeka and Santa Fe Railway System, reported recently that gross capital expenditures for new cars, diesel locomotives and additions and improvements to other facilities were $80,100,000 in 1952. Similar expenditures may approach that level this year if allocations of necessary materials are sufficient to avoid carrying part of the program over into 1954, he said.

At the close of 1952, the railroad had 838 diesel locomotives, representing a gross capital outlay of nearly $200 million, exclusive of the

investment in related servicing and repair units, according to its report. In December, diesels handled 77 per cent of freight gross ton-miles, 93 per cent of passenger car-miles, and 95 per cent of yard switch locomotive-hours.

The road plans that by the end of 1953 there will remain for dieselization only through freight service between Kansas City, Kan., and Clovis, N. M., where the best steam engines are in service. Mr. Gurley indicated that certain other steam engines that could make an appreciable contribution to transportation capacity in emergency conditions were being retained as stand-by power.

Army Tests RR Ambulance Car

The U. S. Army is testing a new type of ambulance railroad car to be used to transport wounded soldiers from port hospitals to hospitals nearest their homes. Independent operation, a big feature of this new car, is made possible by two GE diesel-electric undercar power plants. Rated at 30 kw each, the power plants generate electricity for cooking, refrigeration, air-conditioning and heating. These electric loads require approximately 50 kw per car.

A 50-hp diesel engine is the prime mover of each unit, driving a 220-v AC, 60-cycle alternator which, in turn, generates the electric power for the car. Each car has an automatic load control system to start and stop the power plants according to load level whether the car is operated as a single car or in a series of cars utilizing the permanent trainline connections. Rubber mounting of the engine-alternator set reduces vibrations in the car.

New Horizons in Automation

Julius Y. Kaplan, head of the Servo Section of the Arma Corp., a subsidiary of American Bosch Corp., in an address before the American Society of Tool Engineers, foresaw an era in which most production and tool room machinery will have instrument brains and perhaps all of the difficult labor of production will be done automatically.

Lack of flexibility, he pointed out, has been one of the big reasons why automation thus far is limited mainly to heavy production manufacturers of relatively standardized items. This must be conquered with a new approach, a field of flexible automation developed for the military during the war. "Standard machine tools now in use can be adapted by attaching a brain, so that each will follow any sensible order that it gets. This means we can make present equipment over into machines that can turn out a variety of products automatically—not just one thing . . . Order details —conventionally a drawing—are put on a tape in a language which is understood by the brain. Tooling up consists primarily of changing tapes."

The use of instrument brains in flexible automatic manufacture will not necessarily make conventional machinery obsolete. The brain can be attached to them. Useful equipment now functioning efficiently will not be tossed out either.

The "brain block" techniques of instrumentation wherein precision controls of great variety can be assembled from small accurate interchangeable

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standard components was dramatized five years ago when Arma assembled a few standard components to automate a lathe. The one lathe was made to do the work of seven. It was push-button, operated from a punched paper roll.

Construction Industry Hopeful

A panel of authorities at the San Francisco convention of the American Society of Civil Engineers, far from being apprehensive about possible cuts in defense spending, took a highly optimistic view of the construction future. "Construction of arterial and local highways . . . is a major phase of public works," one view brought forward. "The rising demand for highway improvement unquestionably will add a very substantial construction volume as soon as the defense pressure decreases. Outlook for private enterprise construction is bright."

The U.S. Bureau of Public Roads recently published figures telling a story of progress. For example, miles of state highways (not including local roads) constructed or reconstructed in 1950 and 1951 averaged 41,400 a year, compared with 28,500 in 1947, and is on the increase. High-type surface highways has increased steadily from 6224 miles in 1947 to 15,122 in 1951. Several state governors commenting upon this situation in their 1953 budgets declared that this has been the busiest times in the histories of their states for highway construction.

The "1953 Outlook for the Diesel Engine Industry", published by DIESEL POWER AND DIESEL TRANSPORTATION, in January, reveals that the construction industry is extremely important for replacement potentials. "Total outlay," the report states, "is expected to reach $2,700,000,000 in 1953 compared to $2,450,000,000 for 1952. All told, the construction industry will require 28,700 new diesels in 1953, compared to a final figure of about 23,500 for 1952."

Alloy Casting Research

Fundamental study of corrosion and development of new high strength and high temperature alloys, have been set up as research programs for the next

(*Continued on page* 124)

What Do You Know!

(Answers to question on Page 63)

1. Correct answer is "c". Specific gravities of low API gravity oils are so close to that of water (1) that it is practically impossible to remove it by centrifuging. See the article on Page 56 for details.

2. "b" is correct. A proper cleaning and handling system for the heavy fuel will permit smoke-free operation. For details of such a system and the problems involved, see the article referred to above.

3. Correct answer is "b". Purity of molybdenum disulfide is extremely important because the natural impurities are very abrasive by nature. For details and uses of MoS_2 see the article on Page 90.

4. "b" is correct. The value of molybdenum disulfide as a lube oil additive is highly controversial. In contaminated oil, the MoS_2 may flocculate and form particles large enough to be abrasive or drop out of the oil. For some safe uses see article above.

5. "b" is correct and "c" correct in some cases. Maximum speeds are limited by safety and by law. It is true that more pay load might be hauled, but this is subject to legal limitation. See the article on Page 94 for details.

6. Again, "b" is correct. First statement is true and second is false. For a discussion of the problems, see the article on Page 68.

7. "a" is the basic reason and "b" is the specific cause in many designs. Fuel injector response to governor action is practically instantaneous, but when gas is entrained in the intake air it takes longer to stabilize engine speeds to the new conditions. See the article on Page 96 for details.

8. Correct answer is "a". See the article referred to above.

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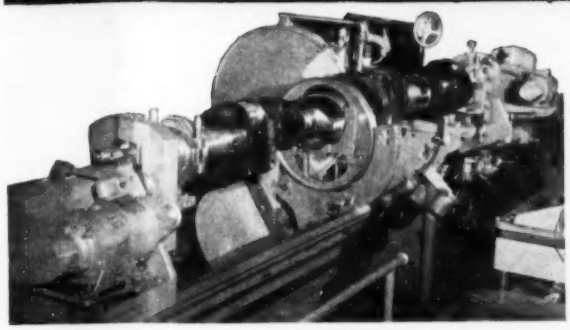

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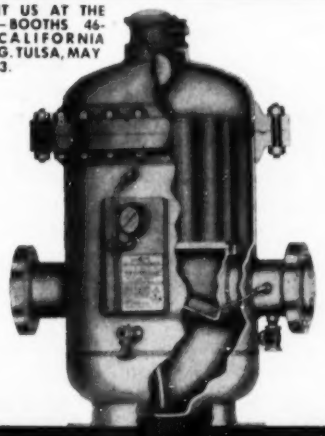

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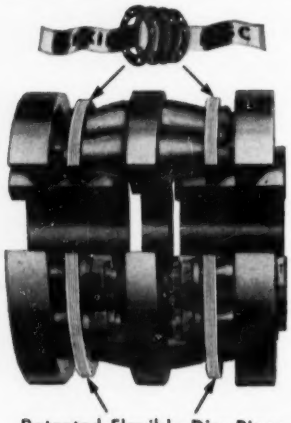

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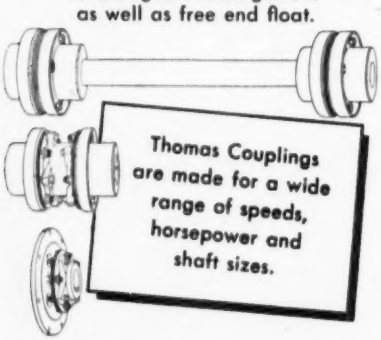

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five years by the Alloy Casting Institute. Looking toward the future needs of high alloy castings users, projects have been designed to increase knowledge of alloy structures and corrosion behaviour. Results of the studies are expected to provide materials useful to meet expanded demands for higher operating temperatures and stronger materials of construction in modern industrial processes.

Continuing scarcity of alloying materials, particularly nickel, makes alternate alloys necessary and several projects are being devoted to accumulation of data on alloy grades infrequently used. Alloy contamination is an attendant problem of utilization of scrap by foundries due to primary metal scarcities. The organization will investigate maximum quantities of "tramp" elements permissible in high alloy castings from viewpoints of foundry characteristics, high temperature strength, and corrosion-resistance.

Oil Reserve Peak Set, Natural Gas at New High

Despite record production levels in 1952, the nation's proved reserves of liquid petroleum and natural gas reached new heights at the year end, according to the American Petroleum Institute and the American Gas Association in their annual reports.

Proved reserves in the ground of liquid petroleum on December 31, 1952, amounted to 32,957,205,000 bbl, an increase of 764,572,000 over the 32,192,633,000 on December 31, 1951. Production last year was 2,541,554,000 bbl and new supplies developed were 3,306,126,000 bbl. In 1951, production was 2,487,873,000 bbl and new supplies developed amounted to 5,137,945,000 bbl.

Known natural gas reserves last December 31, were 199,716,225,000,000 cu ft, compared with 193,811,500,000,000 a year earlier, a net increase of 5,904,725,000,000. Production for 1952 totaled 8,639,638,000,000 cu ft and new supplies developed were 14,544,363,000,000.

More than half the reserves of liquid petroleum and natural gas are in Texas. The compilation shows that at the year's end, known Texas petro-

(*Continued on Page* 126)

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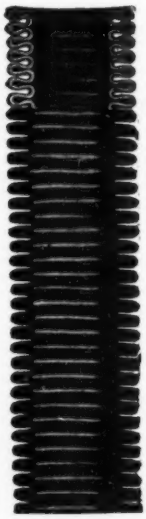

Diesel Bulletins 1020 & 50A furnish complete information.

See our Catalogs in Sweet's Files for Product Designers and Mechanical Industries.

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ONE OF THE FEATURES Responsible for Its Overwhelming Preference by Leading Diesel Manufacturers and Operators

Successive readings may be taken rapidly since no venting of the instrument is required between readings. No closing of valves required to change from firing pressure to compression pressure reading.

For other features, write for Bulletin 294

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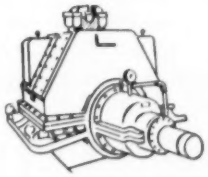
S-N MARINE GEARS . . .

That's what Earl Harvey, Superintendent of the Saint John Tug Boat Company in New Brunswick, thinks about the **unmatched maneuverability** of the Model 5996 S-N Heavy Duty **in-line reverse-reduction gear.**

"For the past year," says Mr. Harvey, "the 'Ocean Hawk II'" — which is powered with a G M C Cleveland 12-567 engine — "was employed on a dredging contract towing the dump barges, and 30% of this time was taken up maneuvering ahead and astern. Under these conditions we have found your gears to be very satisfactory."

Designed to meet the high (1000 H. P.) horsepower requirements of ocean going tugs, the Model 5996 S-N gear is mounted independently from the engine and driven through a flexible coupling for smooth, quiet operation. Because the design permits shifting in **up to 50% less time than is possible** with other gears — **speed of maneuverability,** always an important factor in harbor work, has been greatly **increased.**



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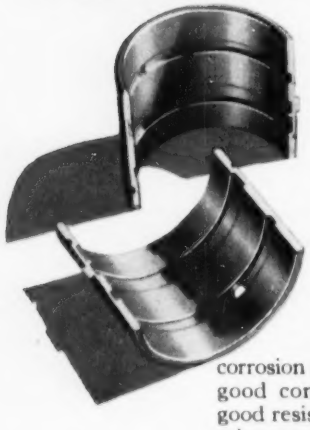

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JOHNSON JB BEARINGS
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JOHNSON BRONZE PRODUCES ALL TYPES OF SLEEVE BEARINGS: BRONZE-ON-STEEL, copper lead • STEEL BACK, Babbitt Lined • BRONZE BACK, babbitt lined • CAST BRONZE, plain or graphited • SHEET BRONZE, plain or graphited CAST ALUMINUM ALLOY • LEDALOYL powder metallurgy

leum reserves were 18,041,269,000 bbl and natural gas supplies were 105,732,763,000,000 cu ft.

The Canadian Petroleum Association also announced that proved reserves of liquid petroleum in western Canada at the end of 1952 came to 1,700,000,000 bbl, an increase of 357,000,000 over the 1951 total.

The Rise of Diesel Power

Rapid transition from steam to diesel-electric motive power on American railroads is given in the following table showing the percentage of railway service performed by diesel and steam locomotives during the last 13 years. Freight is given in gross ton miles, passenger is given in car miles, and yard switching service is given in locomotive hours. Percentages for 1952 are for the first 11 months only.

At the beginning of 1940, Class I roads owned 41,117 steam locomotives and only 510 diesel-electric locomotives most of which were employed in switching and passenger service. Each year since then has witnessed the rapid increase in the use of diesel power and a corresponding decline in the use of steam power. Change has been particularly rapid since the end of World War II.

	Freight	Pass.	Switch.
1940—*S*	97.53	88.55	91.03
D	0.05	5.20	9.65
1942—*S*	97.29	84.54	83.79
D	0.80	8.87	14.89
1944—*S*	94.56	85.87	77.31
D	3.59	8.00	21.32
1946—*S*	88.15	78.24	69.17
D	9.73	15.28	29.46
1948—*S*	76.70	53.92	61.75
D	21.27	39.55	36.95
1950—*S*	53.91	36.31	38.20
D	44.13	57.30	60.45
1951—*S*	45.50	30.89	30.97
D	52.66	62.73	67.79
1952—*S*	32.99	22.06	22.35
D	65.12	71.30	76.39

Trucking Councils to Meet

The American Trucking Associations' councils on safety, equipment and maintenance, and terminal operations, will meet May 11 to begin four days of technical discussions at Dallas, Texas.

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Agenda highlights for the council on equipment and maintenance are: maintenance cost control; "What to expect of the truck of tomorrow"; solutions to the muffler problem; and the care and maintenance of modern cooling systems.

CNR Continues Dieselization

Canadian National Railways president Donald Gordon indicated that his railway does not plan to delay its dieselization program in the Maritimes or elsewhere while waiting for developments in gas turbines. This was in way of answer to requests made by Nova Scotia delegates to the Canadian government that introduction of diesels in the Maritimes (a coal-producing area) be delayed for five years.

During 1952, Mr. Gordon said, his five-year plan for selective introduction of diesel power continued by placing 115 more diesel locomotive units in service, bringing the total number to 395 at the year's end. Twenty-three steam locomotives were retired in the same period. By the end of 1952, his program for switchers was 20 per cent complete and for road service, 34 per cent complete.

Lube Engineering Course

Engineers in industry will have an opportunity to study applications of new techniques and methods in lubrication engineering during a 2-week Special Summer Program from June 16 to 26 at the Massachusetts Institute of Technology. The program is intended primarily for engineers responsible for lubrication maintenance and scheduling in industrial plants and for others who wish to become better acquainted with this field.

The course will cover a wide range of basic and specialized topics, including: theory of hydrodynamic lubrication and its application to the design of thrust and journal bearings; fundamentals of dry and boundary friction; bearing materials; fluid lubricants and greases of all kinds (including synthetic types); solid lubricants; gear lubrication; lubrication of rolling-contact bearings; lubricating systems; and plant maintenance.

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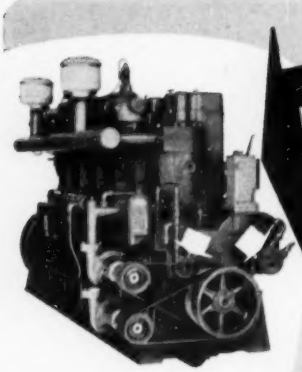

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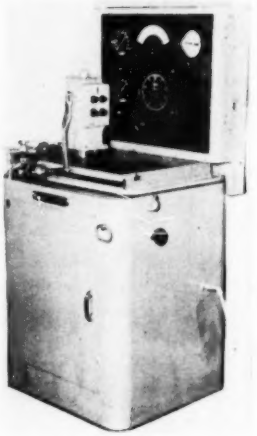

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CONTROL PACKAGE TYPE GM FOR ENGINE GENERATOR SETS

The Burlington Control Package, Type GM, housed in a rugged 14 gauge steel cabinet, contains all essential metering and voltage control for portable or stationary engine generator sets. Meters and cabinet short mounted to minimize vibration. Installs directly on generator, eliminating need for separate switchboard.

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- Automatic and manual voltage regulation
- Dual voltage potential transformer
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- Operating controls conveniently grouped on front of cabinet

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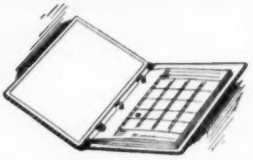

Re-FLECK-Tor OIL LOG BOOK

This oil recorder provides an easy method for checking daily oil and engine operating conditions. It shows you when you should change filter elements; indicates the presence of water, fuel dilution, etc. Ask for yours without delay.

FLECK REPLACEMENT FILTER ELEMENTS

Fleck makes marine and industrial lube and fuel oil replacement filter elements for all makes of gasoline and diesel engine filters. Immediate shipments made from stock. And dealer agencies are still available. Write for interesting details.

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Dual-Fuel Engines for Mines In Wales Utilize Mine Gas

A technically interesting development has taken place in England. Five 700-kw dual-fuel engines and alternators, together with station equipment and accessories, have been installed at the Point of Ayr Colliery, North Wales.

The engines operate on mine gas, having considerable methane content, the gas being obtained from boreholes. Waste heat from the engine jacket water and exhaust gas are utilized for space-heating and pithead baths. Electrical output is employed for operating the winding gear through AC motors, also for driving air compressors and the mine's washing and screening plant.

Engines are of the English Electric 8-cyl RLD class (15-in bore, 20-in stroke), running at 428 rpm, with a piston speed of 1426 fpm. Output is 1100 bhp or 74 psi bmep. Alternators of the same make are directly coupled to the engines of the salient-pole rotating field type, 3 phase, 50 cycles.

Gould-National Opens New Plant

Gould-National Batteries, Inc., has opened a new $3 million factory at Kankakee, Ill., its 21st in the United States and Canada, adding nearly five acres of floor space to the company's productive capacity.

Germans Build Diesel Auto

Another German firm, Carl F. W. Borgward of Bremen, is producing a motorcar model of 1.8 litres. The Borgward-Hansa car has a 4-cyl engine of 3.07-in bore and 3.62-in stroke. Its maximum output is said to be 42 bhp and the road speed is up to 62 mph. At that maximum the crankshaft turns at about 3500 rpm. Compression ratio is 19.8:1.

The unit works on the 4-stroke cycle and combustion occurs within a swirl chamber in which injector is mounted almost vertical. Cold starting is aided by electric glow plugs. Energy for starting is provided by a 12-v set containing a 84-amp battery. Fuel ignition is by Bosch unit-type pump with pneumatic governor, the unit also carrying a fuel-lift pump with hand primer.

Giant Presses for Alcoa

The U. S. Air Force and the Aluminum Co. of America announced completion of negotiations on a contract that will bring two of the largest forging presses in the world to Cleveland. They will be used primarily to make structural aluminum and magnesium forgings for high-speed aircraft. Mesta Machine Co. and the United Engineering Co., in Pittsburgh, are constructing the presses.

Of 35,000- and 50,000-ton capacity, the presses will be housed in a structure equivalent in height to a 10-story office building. The 50,000-ton press will be 80-ft tall, with 36 ft of it below ground level. Steel reinforced concrete foundations, going 30 ft underground, resting on pilings reaching 75 to 80 ft downward, will be needed to support the machinery. They are expected to be put into operation in 1954.

Engine Improvement Research

Engineers at the Cleveland, Ohio plant of the Aluminum Company of America wanted to find a new way to make aluminum blocks and heads to improve high compression performance and reduce engine weight. They knew that the water passage in engine heads make castings expensive. Delicate and intricate cores are used to form these holes and they often break. Frequently they shift as molten metal

HERE IS ONE MAN WHO CAN HELP KEEP CRANKSHAFT RECONDITIONING COSTS DOWN

The initial cost of a diesel crankshaft grinder is the one single item that contributes more to grinding cost than any other factor.

By being the first to redesign cumbersome costly grinders Lempco expanded the opportunities and lowered the cost of shaft grinding.

Shafts from Alco, Cummins, Fairbanks-Morse, EMD, Cooper-Bessemer, Superior, Waukesha, can be reground to manufacturers' tolerance.

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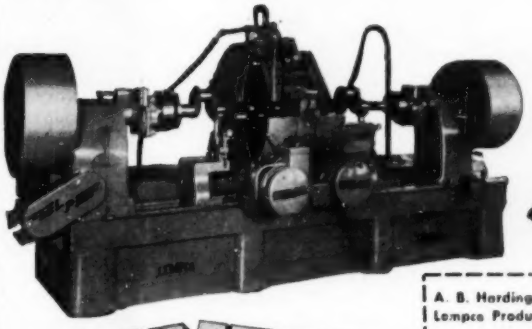

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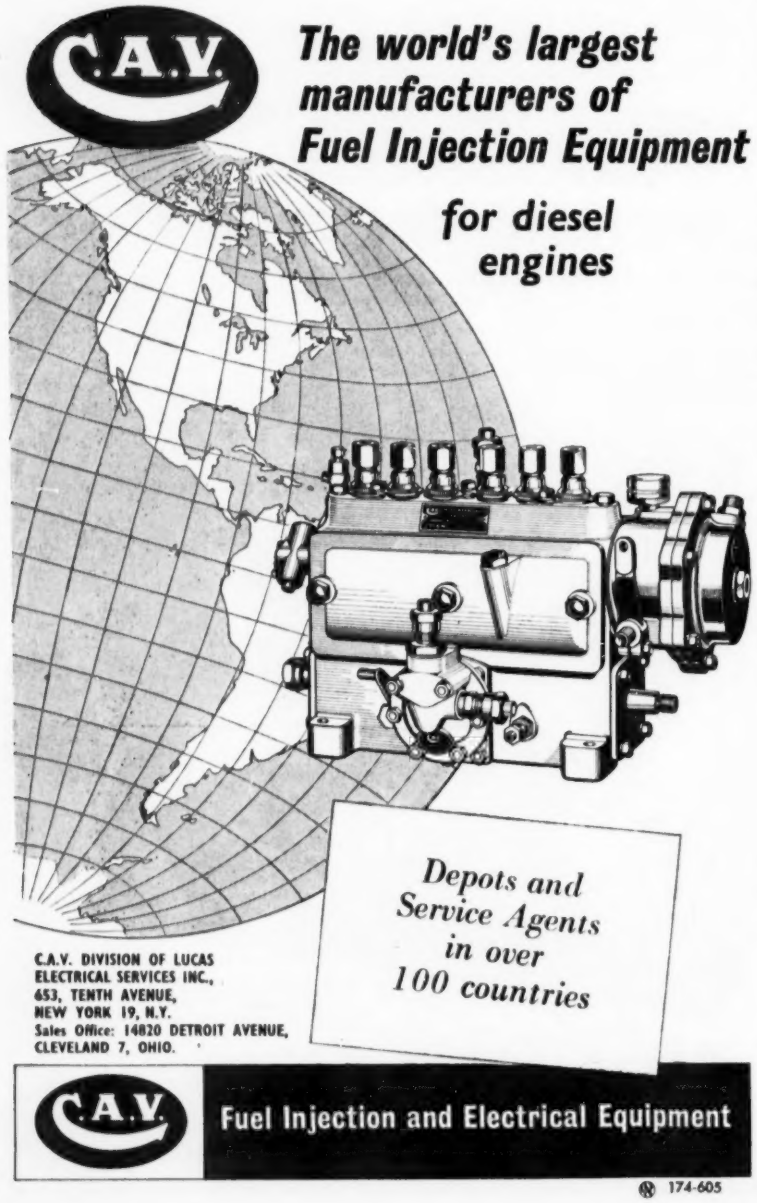
is poured around them. This ruins the casting.

The engineers came up with an idea of designing an engine in sections, like a sliced loaf of bread. The small castings would be easier and less expensive to make; they could then be stacked up with gaskets of brazing metal between. They would go through a brazing furnace and the castings would fuse into a complete head, with no cores, rejects, or clogged passages.

However, putting the idea into operation was not that simple. Alloy selection had to be experimented with, and brazing temperature. Even then the castings might be too strong in some places and too weak in others. To find out, they were coated with brittle lacquer and assembled in a complete engine.

The engine was loaded until the lacquer creaked and showed where the stresses lurked. Castings were tested on tension-compression machines, using electric strain-gauges to duplicate pressures of actual operation. The process of shaving metal on certain parts and adding some on others then began and the castings became stronger and more efficient. Resultant engines are now on test.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Manufactured *vs* Natural Gas

The popular impression that natural gas will cost substantially less than manufactured gas and supplant manufactured gas entirely was shown to be in the category of wishful thinking recently. F. D. Campbell, president of the New England Gas and Electric Association, told the New York Society of Security Analysts that two of the operating gas utilities in the New England Gas and Electric system have been able to manufacture gas from Bunker-C oil, the lowest grade produced, at a price comparable to and even below that paid by other units in the system for natural gas.

In January, according to Mr. Campbell, the average cost of manufactured gas was 59 cents per mcf at New Bedford, Mass., compared with 65 cents per mcf for natural gas at Worcester, Mass.

New Phase in Railroading? Erie Tests Robot Watcher

Robot-controlled trains are seen a possibility with announcement by the Erie Railroad of completion of an electronic system which automatically identifies trains and records their numbers and arrival times. Successful operation of the robot train watcher near Waterboro, N. Y., the first on any railroad, may be the beginning of a new phase in railroading.

The robot system is now limited to identifying four regularly-scheduled freight trains and recording the time each leaves its division to move onto the main line. The identification information is automatically transmitted to a dispatcher located 22-mi way, where a light remains burning until it is distinguished by the dispatcher. Passing time is electrically recorded.

The watcher consists of an identifying coil beneath the caboose, another coil installed in the track at the passing point, and the control machine in the dispatcher's office which records the information on a moving tape. When the record shows the train has passed the point, the dispatcher knows

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LARGEST CRANKSHAFT GRINDER IN A JOBBING SHOP

the section of track is clear and he can admit another train.

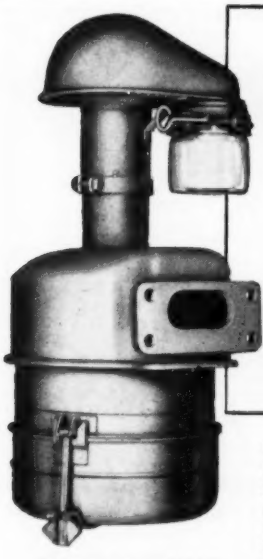
The robot installed between the tracks is connected to an electrical source and serves as a radio transmitting station. The transmitter does not operate constantly but is turned on automatically when the locomotive approaches the robot.

The railroad believes that many applications of the simple electronic principle are possible. The idea might be expanded to include the opening and closing of switches for and after the passing of specific trains, to turn on lights at certain unattended passenger stations, and to automatically announce by public address system, recording arrival and route of an approaching passenger train.

Cummins LA Plant Expanded

Cummins Service and Sales has remodeled and enlarged its Los Angeles plant to give faster service in engine rebuilding, repairs and parts. A new building has been added for more floor space to rebuild engines on a production line basis. Another new building houses a double-end dynamometer to permit one engine to be tested while another is being worked on.

Parts inventory has been increased to the point of maintaining a supply of more than 7500 different parts, largest stock of Cummins parts in the world outside of the Cummins Factory, according to the parts manager.



Donaldson Air Cleaners are EASY TO SERVICE!

The simplicity and speed of servicing Donaldson Air Cleaners encourages regular attention by the machine operator. No tools are needed to remove oil cup. Cleaning cup and re-filling with oil is a two-minute job. Removable tray makes cleaning out chaff, lint, leaves and larger foreign particles simple and fast.

CUSTOM-BUILT TO FIT YOUR ENGINE

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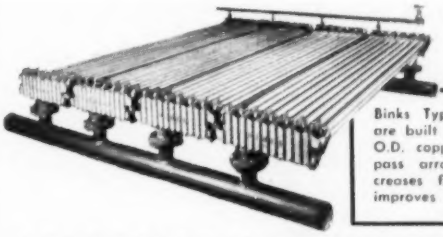

Binks Type "D" coils are built of heavy 1" O.D. copper tubes. 3-pass arrangement increases fluid velocity, improves efficiency.

STOP SCALE IN DIESEL JACKETS

...with Binks Heat Exchange Coils

With Binks Type "D" Heat Exchange Coils, you eliminate scale by using distilled or chemically treated water in a *closed* system. This pure water goes from the engine jacket to the heat exchange coils, which are located in a standard Binks cooling tower. There, the spraying of raw water on the coils cools the jacket water. Raw water and jacket water never mix. Hence, minerals and other scale-forming impurities cannot contaminate the engine's jacket water.

MAIL COUPON for Bulletin 41—It's FREE!

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Gentlemen: Please rush me a FREE copy of Bulletin 41 containing informative charts, drawings, etc. on your Heat Exchange Coils.

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Organizational News

Fairbanks-Morse Changes

William B. Morse, formerly assistant to the manager of the Detroit sales and service branch of Fairbanks, Morse & Co., has been appointed manager, succeeding E. J. Hay deceased.

Mr. Morse is a great grandson of the founder of the company and son of Robert H. Morse, Jr., president. He has been with the company since 1946, starting in the Beloit Works. From 1948 to 1951, he was a salesman for the San Francisco branch until his transfer to Detroit.

Other changes announced were: B. R. Eng to assistant comptroller; J. E. McQuilkin, assistant to the president of The Canadian Fairbanks-Morse Co., Ltd.; F. M. Mason, Jr. to coordinator of Government business; J. F. Weiffenbach to chief product engineer of the manufacturing division; W. E. Watson to works manager, Canadian Locomotive Co., Ltd.; J. R. Walsh to manager of the new Kansas City plant; and, W. P. McAnally to manager of the Stuttgart Works.

Wm. B. Morse

Stanley Wright

Baldwin Diesel Representative

Stanley Wright, long-time diesel engineer, has been appointed special representative for Hamilton and Baldwin diesel engines in stationary power and marine applications in the New York area, it was announced by Baldwin-Lima-Hamilton Corp.

Mr. Wright's entire career has been devoted to diesel engineering and sales. His work was largely with Busch-Sulzer. He is a member of the American Society of Mechanical Engineering.

Young Radiator Promotion

Anthony D. Bogus, sales engineer, has been advanced to the position of assistant sales manager of the industrial and oil field division of Young Radiator Co., it has just been announced. In addition to his new responsibilities, Mr. Bogus will continue to handle sales and engineering of oil field and heat transfer equipment.

GE Locomotive Lab Manager

The General Electric Co. announces appointment of Marvin J. Kolhoff as manager of the locomotive and car equipment department laboratory, at the company's Erie Works, to succeed E. H. Horstkotte who has retired. The laboratory is a research and development center for perfecting new and improved electric traction equipment.

Mr. Kolhoff joined the company in September 1939, and in 1942 became a requisition engineer in the locomotive and car equipment department. He was appointed administrative assistant of the control engineering division in 1946, and five years later was named assistant engineer of the laboratory, the position he held prior to his recent appointment.

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Now available. Kent-Moore's comprehensive new GM Diesel Service Tool Guide. Describes and illustrates more than 300 special tools, developed expressly to meet the essential maintenance requirements of your GM Diesel engine applications. Tools that will save you money, time, and labor. Send for your copy of this Guide today! It's FREE!
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200 KW, 900 RPM, Protected, Two Bearing D.C. Generator.

A. C. AND D. C. GENERATORS. For the greatest exhibition of quality and service use performance proved Columbia A.C. and D.C. Generators. Available for coupled service, belt drive, single or two bearing.

A. C. Generators: 6¼ to 1000 KVA
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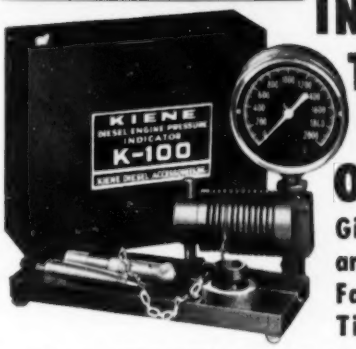
DIESEL INDICATOR TELLS YOU WHEN TO OVERHAUL



Gives Compression and Firing Pressures Faster — Saves You Time and Money!

With the KIENE DIESEL PRESSURE INDICATOR, you waste no money on costly overhauls done too soon—take no risk of putting off overhauls until too late.

The KIENE INDICATOR tells, reliably by accurate measurement of compression and firing pressures, when your engine needs attention.

SIMPLE—no complicated adjustments. **RELIABLE**—not affected by heat. **ACCURATE**—effects of friction and inertia eliminated. **RUGGED**—only one moving part. **COMPACT**—weighs less than ten pounds.

LOW IN COST—For full details, send for Bulletin K-100.

KIENE DIESEL ACCESSORIES, INC.

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Alco Diesel Advancement

John P. Delaney has been appointed general manager, transportation services, of the American Locomotive Co. He will be in charge of sales of diesel locomotives and renewal parts, factory rebuild service, and locomotive field service, as well as sales of diesel engines and parts for marine, pipeline and other stationary installations.

According to W. S. Morris, executive vice president, Mr. Delaney's new post was created "to consolidate locomotive and diesel engine sales and service operations and intensify our efforts to serve the transportation industry."

Mr. Delaney joined the manufacturing department at Alco's Schenectady plant in 1937, immediately after graduation from Union College, and in 1941 was transferred to the service department at St. Louis. He began his sales career in 1944 when he was assigned to the New York sales office. Two years later he became manager of technical sales for the company at Schenectady and in 1950 was named manager of Alco-GE sales and field service division.

J. P. Delaney

J. C. Morrison

Federal-Mogul Manager

Announcement has been made of the appointment of James C. Morrison to manager of the Detroit plant of Federal-Mogul Corp., to succeed P. J. Potter who has requested an extended leave of absence for health reasons.

Mr. Morrison was formerly an assistant to the vice president of manufacturing. He had acquired experience in manufacturing management while serving as an industrial engineering consultant for the firm of Ernst & Ernst for five years prior to becoming associated with Federal-Mogul in 1950.

LeTourneau Vice President

John W. Schoen has been appointed vice president and general sales manager of R. G. LeTourneau, Inc., to direct the company's sales division and other related departments. He replaces R. E. McCluskey who recently resigned.

In 1943, after having been associated with the Firestone Tire and Rubber Co., Mr. Schoen joined the LaPlante Choate Co. and rose to vice president in charge of sales, a position he held for the past four years. Early this year, when Allis-Chalmers Co. acquired the LaPlante properties, he resigned to become consultant for the David Brown Industries, a British manufacturer of construction machinery.

Ethyl Research Supervisor

Ethyl Corp. has appointed T. Wayne Warren as supervisor of research in refinery technology at its Detroit research laboratories. He will be associated with expansion of research in the fuel technology field.

Ohio Crankshaft Advancement

Appointment of Chester H. Kimmel to the post of vice president and general manager, has been announced by W. C. Dunn, president of The Ohio Crankshaft Co.

Mr. Kimmel started his career as a factory worker with The Advance Rumley Co. (now a part of Allis Chalmers). He was then associated for many years with The Studebaker Corp. and The Packard Motor Car Co. He joined Ohio Crankshaft as factory manager of the crankshaft and camshaft division, advancing to general manager of that division in 1946. Last year he was elected a vice president.

Chester H. Kimmel

Mack Assignments

Mack Motor Truck Corp., announces appointment of K. L. Fitts to manager of off-highway truck sales and R. W. Walker, a vice president, to manager of the company's bus division.

Mr. Fitts joined the company in 1945 as a national accounts salesman, and in 1951 was made assistant manager. In his new position he succeeds P. J. Fleming who recently retired. Mr. Walker became associated with Mack in 1924, and during the late twenties was responsible for the sales of many of the first buses used in New York. He has served as sales manager of various district and division offices.

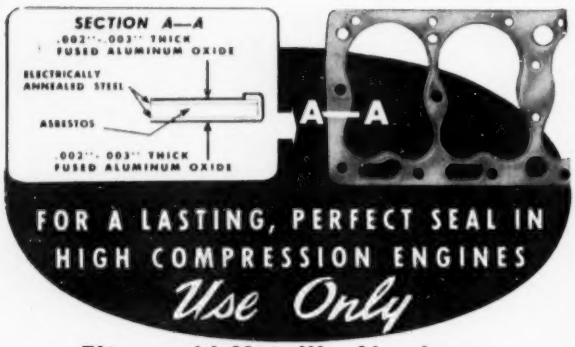
Pesco Supercharger Sale

The Pesco Products Div. of Borg-Warner Corp. has concluded an agreement with the Dexter Folder Co. for the purchase of Pesco's supercharger business, including all manufacturing, sales, engineering and service facilities. Sale was announced by R. J. Minshall, president of Pesco, who explained that the division will now devote all of its facilities to manufacture of hydraulic equipment.

Dexter will transfer Pesco's supercharger facilities to a new division to be known as Miehle-Dexter Supercharger Div. to be located in Racine, Wis., all of whose products will be manufactured by the Christensen Machine Co., a wholly owned subsidiary of Dexter. By locating this operation in Racine, Miehle-Dexter will be in a centrally-located position to serve the diesel engine industry.

Mr. Hans Bohuslav, well known in the diesel field, has been ap-

Hans Bohuslav



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Grease Retainers — Cork Gaskets

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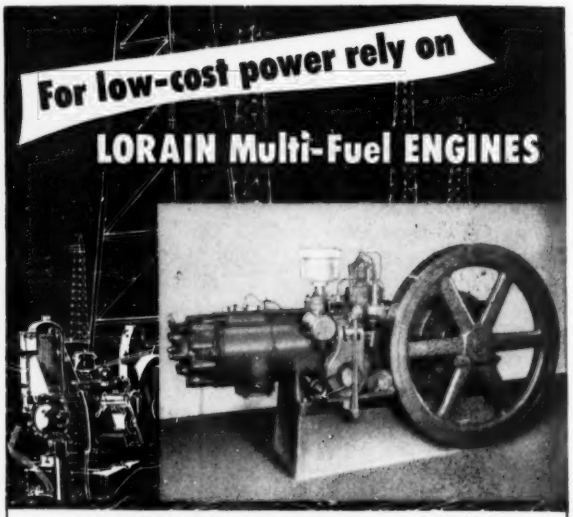
There's a Fitzgerald Gasket for every Engine



55 HP Lorain Model DA with gasoline starter

. . . full line from 10 to 55 HP

Lorain diesel or gas engines are built with an extra margin of stamina to stand up to gruelling service. Simple 2-cycle, single-cylinder design reduces moving parts for dependability. They operate as cold-starting diesels or can be converted easily and quickly in the field for natural gas or butane.

Get full details on Lorain Multi-Fuel Engines. *They operate longer without attention . . . operate longer between overhauls.* Write for specifications today. A-6972

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SAVE WITH INTERSTATE LOW COST DOUBLE-TESTED

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Interstate Diesel Service Features:

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2. Every part carefully inspected. Only genuine replacement parts used when needed.
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4. Every unit thoroughly double-tested and guaranteed to meet the most rigid specifications.
5. FOR SMALL EXTRA CHARGE WE WILL CONVERT ANY INJECTOR FROM ONE SIZE TO ANOTHER.
6. 60-70-80-90 and DF6's available from stock. Exchange size for size.

NOTE: Check our repair service on series No. 110 injectors, fuel transfer pumps and blowers.

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Attractive Distributor and Dealer Propositions Left in a Few Areas—Write!

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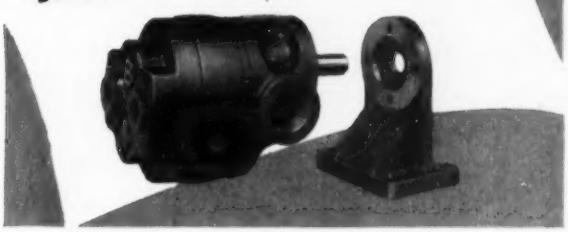
"AMERICA'S FINEST DIESEL COMPONENT REBUILDERS"

Built for High-Pressure Lubrication



500 Series Rotary Geared Pumps

If your problem is high-pressure lubrication, Brown & Sharpe 500 Series Pumps are your answer. They're designed to operate at pressures up to 500 psi . . . built to run smoothly and dependably at high speeds. Self-balancing mechanical seal prevents leakage . . . eliminates glands. Six sizes deliver from 5 to 37.5 gpm at 0 psi. All joints are ground . . . no gaskets.

For further information, write for Pump Catalog. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

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BROWN & SHARPE BS

pointed general manager of the division. He was previously with R. G. LeTourneau, Inc., Longview, Texas and Peoria, Ill. Prior connections were with Sterling Engine Co., Buffalo, N. Y. as vice president in charge of engineering and with Enterprise Engine Co., San Francisco, Cal. as chief engineer and vice president.

Electro-Motive Promotes

Appointment of D. O. Brooks as sales manager, and W. R. Instone as branch representative of the Jacksonville factory branch of General Motors' Electro-Motive Div., has been announced.

Mr. Brooks joined Electro-Motive in 1939 as a stock clerk and progressed to branch representative, the position he held before his latest appointment. Mr. Instone joined the division in 1950 following service with the U.S. Navy. He served as a senior clerk prior to his present appointment.

Another change in the division was the appointment of J. F. Kidwell to the post of district engineer with headquarters in Denver, Colo. He joined Electro-Motive in 1941 as an apprentice draftsman, progressing to manager of the maintenance section and serving as a service engineer before this latest advancement.

Ringsby Elevations

Ringsby Truck Lines, Inc. announces selection of R. Mack Reid, formerly Salt Lake City terminal manager, to fill the newly created position of superintendent of all terminals in the company's system. N. B. Gale succeeds him in his former position.

Mr. Reid served as president of Comet Motor Express, before it was purchased by Ringsby in 1948. Following purchase he was appointed manager of the Salt Lake City terminal and has held that position until his recent appointment. Mr. Gale has successively served as manager of the Casper and Grand Junction terminals and was recently engaged in an education program on freight checking and loading before appointment to his new position.

Miller Buys Bonney Forge

Joseph W. McDougal, president of Miller Mfg. Co., announces purchase by his company of Bonney Forge & Tool Works, manufacturer of mechanics' hand tools. Under the new ownership, Bonney management will be directed by Mr. McDougal. Arthur J. Male, former president, will be chairman of the board of directors, and Fred S. Durham, Jr. will continue as vice president and secretary.

Borg-Warner Executives Named

Major reorganization of the top executive staff of Borg-Warner Corp. was announced recently with the naming of three new vice presidents. According to the president, Roy C. Ingersoll, "the need for additional operational executives has been dictated by the overall growth of Borg-Warner and by the increasing diversification of the products which we make."

L. G. Porter, treasurer, now becomes administrative vice president and treasurer. R. S. Ingersoll, president of the Ingersoll Products Div., was also

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elevated to an administrative vice presidency. They each will assume executive supervision of a group of divisions and subsidiaries within the corporation, Mr. Ingersoll retaining presidency of the Ingersoll Div. Robert W. Murphy, general counsel, was elected vice president and general council. In addition to other executive duties to be assigned him, he will continue as head of the legal department.

Caterpillar Appointments

L. C. Allenbrand has been named general manager of the York, Pa. plant of the Caterpillar Tractor Co., heading a list of three key appoint- Other appointments were Hans Erich to factory manager at York and Frank Bovenschulte to manager of the merchandise department.

Mr. Allenbrand has been manager of the merchandise department since 1944, having been associated with the company since 1931. Prior to this appointment, he had been defense coordinator and later selective service coordinator during World War II.

Mr. Erich, who has been with the company since 1928, starting as a machine operator, subsequently served as foreman, general foreman, and superintendent of the tractor factory. In 1952, he was promoted to assistant factory manager at Peoria.

Mr. Bovenschulte came to the company in 1929 as a painter in the parts department. In 1934 he was transferred to the merchandise department, where he has since served.

New Hilliard Representative

Appointment of Jules D. Gratiot Co., Los Angeles, as California representative for The Hilliard Corp., has been announced.

Columbia Buys 2 Tool Concerns

Columbia Machinery and Engineering Corp. has acquired all of the assets and manufacturing rights of the Bridgeport Safety Emery Wheel Co., Inc. and the Diamond Machine Co. of Connecticut. The acquisition climaxed several months of negotiations and it was reported that the companies were purchased for cash.

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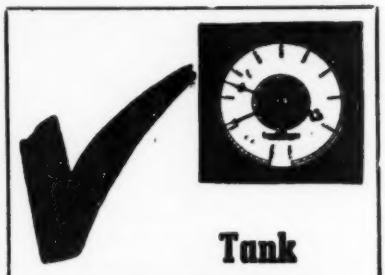

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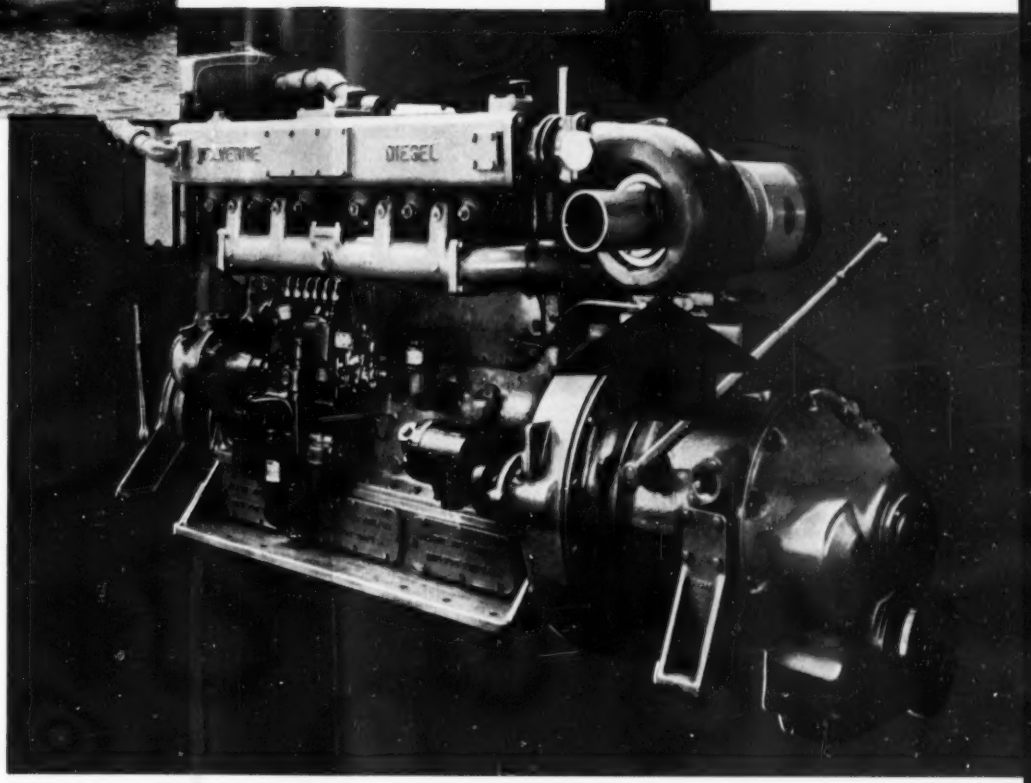

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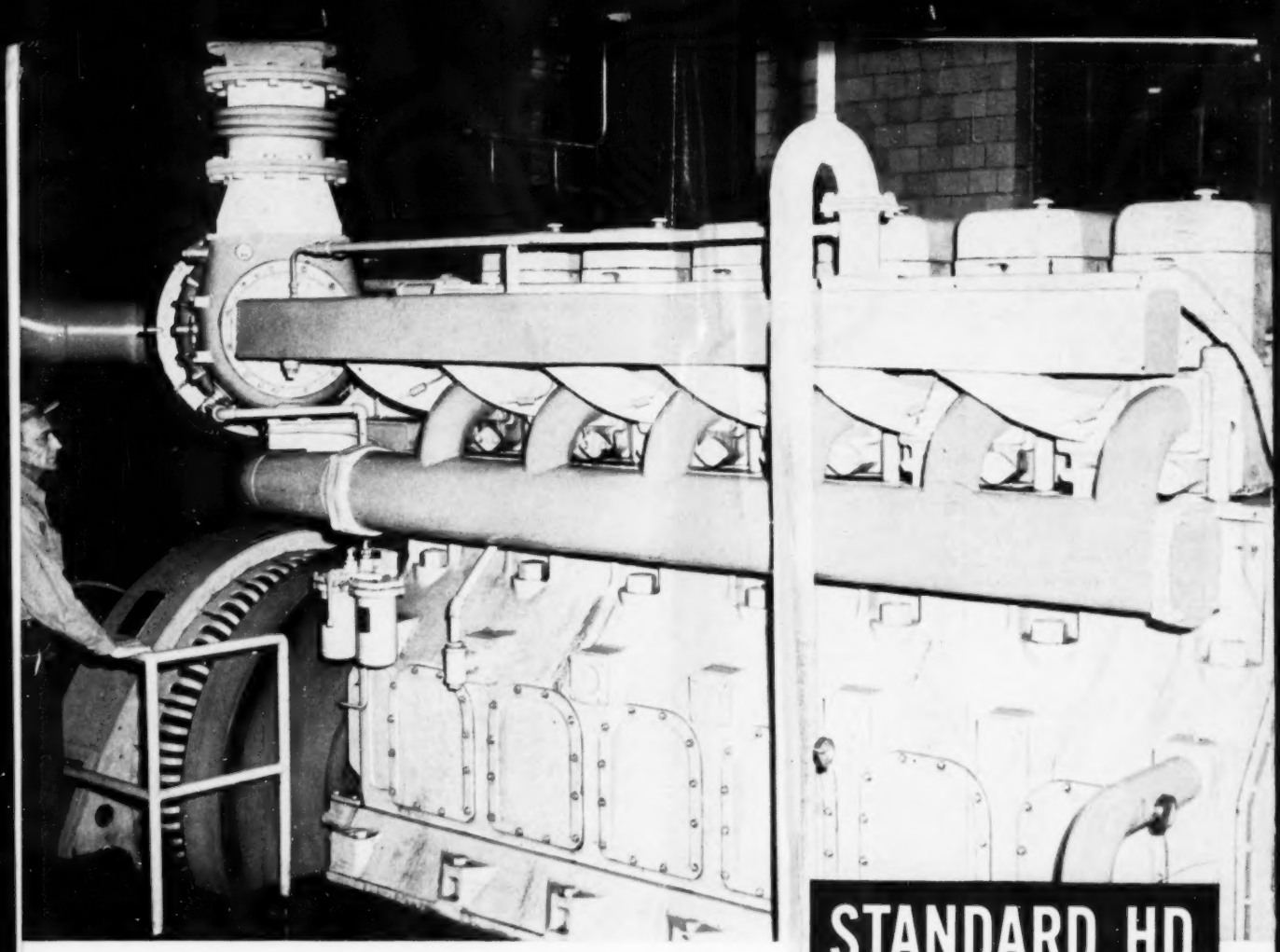

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